UNIFIED FRAMEWORK FOR CONSTRUCTION PROJECT INTEGRATION AND ITS POTENTIAL ASSSOCIATION WITH PROJECT PERFORMANCE

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UNIFIED FRAMEWORK FOR CONSTRUCTION PROJECT INTEGRATION AND ITS POTENTIAL ASSSOCIATION WITH PROJECT PERFORMANCE

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To my husband, my parents and my sister

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LIST OF SYMBOLS AND ABBREVIATIONS

AEC	Architecture Engineering Construction
AGC	Associated General Contractors
AIA	American Institute of Architects
ANOVA	Analysis of variance
BC	Building Construction
BIM	Building information modeling
CB	Category boundary
Cit	Citations
CII	Construction Industry Institute
CSIA	Critical success attribute for achieving project integration
CSRF	Construction Science Research Foundation
2D	Two dimensional
df	Degrees of freedom
IA	Integration attribute
IDP	Integrated design process
IM	Industry meeting
IPD	Integrated project delivery
IRB	Institutional Review Board
MANOVA	Multivariate analysis of variance
PPC	Project success or project performance criteria
SAS	Statistical Analysis Software
Sig	Statistical significance

TPD	Traditional project delivery
UK	United Kingdom
US	United States

SUMMARY

The construction industry is not performing as desired by the stakeholders that compose it. Several authors and practitioners have claimed that moving the industry towards a more integrated approach to project delivery could notoriously improve the overall performance of the industry. The main purpose of this study was to obtain a unified framework for project integration, by identifying the critical success attributes for achieving project integration, the different levels of importance of attributes other than the critical success attributes to improve the integration process, and by determining if there are major differences among the perceptions of respondents depending on their role in the industry. In addition, this study also sought to identify potential associations between the integration attributes and the different project performance or project success criteria.

In order to develop this framework and to identify the potential associations between integration attributes and project performance, a survey was conducted. The sample of the survey was composed of construction industry practitioners; it included owners, facility managers, engineers, specialty consultants, general contractors, subcontractors, among other professionals. The sample size was 264 respondents. The main method used for developing the framework was the Thurstone Scaling Method of Successive Interval Procedure; In addition, this method was complemented and validated using correlation analysis, factor analysis, cluster analysis and analysis of the means.

According to the perception of respondents, 19 attributes out of the 45 attributes under study, were identified as critical for successfully achieving project integration, these attributes are:

- open and continuous communication
- early involvement of key project participants
- organization and project manager leadership
- information share and exchange
- trust
- timely responsiveness
- owner commitment
- personal attitudes and commitment
- efficient coordination
- adequate resources
- top management support
- atmosphere of mutual respect
- clear responsibilities and accountability structure
- early goal definition
- knowledge share
- common goals and objectives
- team selection criteria
- intensified planning
- contracting structure that fosters collaboration

Four other categories of importance were identified and the other integration attributes were categorized accordingly.

No major differences were found between the perceptions that different project participants had in regard to the importance of the different attributes to achieve project integration, leading to the conclusion that the perception of respondents in regard to this matter is very homogeneous.

The potential impact of the 45 attributes on 12 performance criteria was analyzed. Although further research is needed in this arena, interesting results were found. The 12 performance criteria under study are:

- cost
- time
- health and safety
- environmental impact and sustainability
- quality, functionality
- user satisfaction
- owner satisfaction
- design team satisfaction
- construction team satisfaction
- productivity
- claims and litigation

According to the perception of respondents, most of the integration attributes have different levels of impact on the different performance criteria.

Most of the integration attributes are divided in two groups depending on their behavior across all integration criteria; in addition there are three groups that have one attribute each. The potential impact of each of these groups differs from one performance criterion to the other; however there are some performance criteria where the behavior of the groups is similar. The groups have a similar behavior on cost, time, and productivity; they also behave similarly on quality and owner satisfaction; on functionality and user satisfaction; and on health and safety and environmental impact and sustainability.

It is important to take into consideration that previous experience of respondents may influence the ratings they gave to the importance of the integration attributes for achieving project integration and to the potential impact of the integration attributes on performance criteria. In addition, each respondent rated just five random integration attributes on their potential impact on performance criteria.

CHAPTER 1

INTRODUCTION

The construction industry is not performing as desired by clients and by the different stakeholders of the industry. It is well recognized by several authors that the lack of construction performance is directly associated with fragmentation, as well as with other characteristics present in the construction industry. Therefore, researchers in this subject and the industry itself have begun to realize that the industry needs to move towards a more integrated approach to project delivery. However, the industry has not reached a consensus on the attributes that characterize integration, and a validated relationship between integration and improvements in performance has not been determined.

The main objective of this study was to establish a unified definition of project integration, by developing a unified framework of project integration that outlines the critical success attributes for achieving project integration, and the importance of other attributes that are not critical for integration but that help to some extent. In addition, this dissertation also sought to explore potential associations between integration attributes and different project success or project performance criteria.

This document presents the process used to perform this study and the results obtained. Motivation that led to develop this research and its impacts are presented in Chapter 2. Objectives are explained in Chapter 3. Literature review is presented in Chapter 4, the literature review is composed of the characteristics of the construction industry that are preventing it from achieving the desired levels of performance; the different approaches that currently exist to project integration and the attributes identified as important to successfully achieve project integration; and the description of some of the theoretical associations between project integration and project performance. The conceptual framework of integration and its association to performance developed based on the findings on the literature review is presented in Chapter 5. The methodology used to conduct this study is presented in Chapter 6. The development of the survey as the main data collection instrument used in this study is presented in Chapter 7. The results obtained in regard to project integration attributes and their discussion are presented in Chapter 8. The results obtained in regard to the potential associations between project integration and project success or performance criteria are found in Chapter 9. A summary of the unified framework of construction project integration is presented in Chapter 10. Future research topics are presented on Chapter 11. And conclusions are presented in Chapter 12. Finally, some appendices are presented at the end of the document. The appendices include information about the survey process and the survey itself, and the complete results of all of the different analyses performed.

The main contribution of this dissertation was to develop a unified framework of project integration using the attributes identified as critical for successful project integration, and different levels of importance for other attributes. In addition, preliminary associations between project integration and project performance were identified. A unified project integration framework has implications in terms of the body of knowledge and in terms of the body of practice. It can help project team members identify which strategies should be implemented to improve the integration of the project and the performance of the project. It can help educators and trainers to determine which areas to focus in and which approach to use in those areas. It has advanced the current knowledge with regard to project integration.

CHAPTER 2

MOTIVATION AND IMPACT

It is well stated in current literature that the construction industry needs to have a radical change in order to achieve the performance levels required by clients, and to remain competitive in today's world. The expectations of clients, and the criteria they use to assess the success of a project, have evolved as well. The market is more competitive and global, new generations of facility users have different expectations about their work place, concern about environmental and social impact of the industry has grown, and technology development has matured to a point where there are tools that can help promote a more straightforward project process.

Most authors coincide that the most adequate response to face those new challenges and to improve performance of the industry is to transform it towards a more integrated approach. However, it has not been an easy task to define project integration and to understand its real impact on the overall performance of the project.

Today there is not a clear and validated measure of project integration, making it very difficult to make a reliable conclusion on the relationship between project integration and performance (O'Connor 2009). In addition, there are different approaches to project integration; however they can only have a future if their proposed process has a better measurable result than the traditional methods; and at present there are very few empirical studies that provide such information (O'Connor 2009).

Moreover, if it can be proved that integration can lead to improvements in performance, and it can be assessed how well integration is taking place in the project, performance can be managed in a proactive way rather than in reactive way after poor performance has occurred (Baiden, et al. 2006). Without a consensus on what integration is and how to measure it, it is very difficult for construction project managers and senior executives to allocate resources in the best way and to make informed decisions instead of making decisions based on intuition (Yeung, et al. 2007).

Therefore, from the industry perspective, it is very important to establish a consensus framework for project integration and to identify the possible associations that may exist between project integration and project performance. This framework can be used in the near future, to develop tools to measure integration and its quantified impact on construction performance. In addition, the identification of integration success attributes and their association to performance gives useful information that can be used by educators and trainers to develop new skills in young professionals and practitioners, and educate them on new trends of the industry.

CHAPTER 3

OBJECTIVES

General Objective

The main goal of this research is to develop a unified integration framework for construction projects, by identifying the critical success attributes for achieving project integration and by categorizing the importance of other attributes that help the integration process to some extent. In addition, this research seeks to explore the potential impact of project integration on performance and other project success criteria. It is understood that there are no ongoing construction projects that implement all integration attributes and there are a very limited number of completed projects that have used integrated project delivery to measure performance and have conclusive results.

Critical success attributes are the different attributes that are very important to achieve something specific, in this case, project integration. The identification of these attributes contributes to a comprehensive understanding of success and failure in this context. On the other hand, success criteria are the standards, indicators or metrics used to evaluate if the project has been completed successfully (Koutsikouri, et al. 2008). Therefore, success attributes and success criteria are interrelated but are not the same. The identification of critical success attributes for project integration is very important to determine which aspects should be taken into consideration when trying to integrate a project (Fortune and White 2006). Project success criteria are related to project outcomes and performance.

Specific Objectives

The specific objectives of this project are:

- To define project integration by identifying the critical success attributes needed to achieve project integration and by determining the importance of other attributes that are important to integration to some extent.

  In order to identify the importance of the attributes required to achieve project integration, a comprehensive literature review was conducted, and the attributes defined by different authors were extracted. A survey targeted to industry practitioners was conducted to determine the perceived importance of each attribute for achieving project integration.
- To determine the dimensions of the importance of project integration.
- To determine if there are differences in the perceived importance of critical success attributes needed to achieve project integration, depending on the different industry roles that project participants have.

  The roles in the industry that were studied were: owner and facility manager, architect, engineer or specialty consultant, and general contractor and subcontractor.
- To start identifying if the attributes needed to achieve project integration have a potential impact on performance factors or project success criteria.

  The definition of performance factors or project success criteria, are not part of the scope of this dissertation, because extensive research has been conducted on those topics by other authors. Therefore, for the purpose of this dissertation, the project success criteria employed were built upon the comprehensive model developed by Chan and Chan (2004), with the addition of other relevant attributes (i.e., claims and litigation, productivity).

CHAPTER 4

LITERATURE REVIEW

Construction Industry Background

The construction industry is based on the work of different professional teams that are brought together, at different stages of the project, to translate client requirements into built facilities (Amor and Anumba 1999) through a very dynamic process (Chan, et al. 2004). According to Chua et al. (1999) a typical construction project is comprised of design consultants and a construction team. The project environment is determined by the project characteristics, contractual agreements, project participants, and the interactive processes that involve project participants (Chua, et al. 1999).

Characteristics of the Construction Industry that are Preventing it from Achieving Desired Performance Levels

Even though the construction industry is one of the most important segments of the economy, it has several characteristics that are preventing it from achieving desired performance levels (AIA National and AIA California Council 2007, Egan 1998, Kumaraswamy, et al. 2005, Rahman and Kumaraswamy 2004, Sun and Aouad 2000, Tang 2001), in terms of its own needs and in terms of clients' needs (Egan 1998). Productivity levels are very low compared to other industries and in some cases have decreased over the years (AIA National and AIA California Council 2007, Egan 1998, O'Connor 2007, O'Connor 2009, Rahman and Kumaraswamy 2004, Sullivan 2009). Associated with low productivity is poor or inconsistent profitability (Egan 1998, O'Connor 2007). O'Connor states that the construction industry in the US is the second worst performing industry in terms of return of investment (O'Connor 2007, O'Connor 2009), while Egan (1998) states that in the UK, this industry has a low and unreliable rate of profitability.

Other consequences of poor project performance encompass time and cost overruns (CURT 2004, Rahman and Kumaraswamy 2004), poor quality, customer dissatisfaction, lengthy and costly disputes, and disruption of relationships between contracting parties (Baiden, et al. 2006, Chan, et al. 2004, Rahman and Kumaraswamy 2004).

Furthermore, other impacts associated with the construction process and building operation are noise, air and water pollution, solid wastes, land contamination, loss of land, high energy consumption, high consumption of water and other resources, among others (Tang 2001).

Moreover, the construction industry presents several inefficiencies and it is very ineffective when compared to other industries (Amor and Anumba 1999, Chan and Chan 2004). Schwegler et al. (2001) suggest that the main sources of such inefficiencies in projects are discretionary design changes during construction, waiting for work, deficiency rework, unforeseen site conditions, untimely procurement strategies, unnecessary movement of inventory, and poor coordination of design and specifications. Egan (1998) affirms that in the UK, up to 30% of construction is rework, labor is used at 60% maximum of potential efficiency, accidents encompass 3-6% of total project costs, and 10% of materials are wasted. Similarly, CURT (2004) affirms that 30% of the cost of construction is wasted in the field because of coordination errors, labor inefficiencies, material waste and other problems associated with the current construction approach. In addition, Zuppa et al. (2009) state that according to the NBIMS in 2008, gross spending in the US construction industry was of approximately $1.28 trillion dollars and 60% of the spending can be considered waste.

The industry overall has a poor image and is associated with bad workmanship (Dulaimi, et al. 2004, O'Connor 2007, Tang 2001), failure to perform (Dulaimi, et al. 2004) and serious safety risks (Lichting 2005). In 2003 there were 1,500 nonfatal accidents and 4 deaths per day in the United States (Lichting 2005). Poor image, failure to perform, and safety risks are the cause for several well qualified professionals to prefer a job in other industries (O'Connor 2007).

Poor performance has been attributed by several authors to different characteristics of the industry in terms of work environment, inability to work as a team, fragmented communication, blaming culture, the contracting and reward structure, and the team selection process. Those characteristics are described in the following paragraphs.

Project Delivery Fragmentation

The construction work environment is very different compared to other industries, especially because work is fragmented between different stakeholders and different sub-processes, (AIA National and AIA California Council 2007, Baiden, et al. 2006, Chan and Chan 2004, CURT 2004, Egan 1998, Luiten, et al. 1998, Mitropoulos and Tatum 2000, O'Connor 2007, O'Connor 2009, Tatari 2009, Rahman and Kumaraswamy 2004, Sullivan 2009, Sun and Aouad 2000, Tang 2001), who many times are geographically dispersed. The industry consists of several different firms, which most of the times are medium or small in size (Dainty, et al. 2001, O'Connor 2007), Sun and Aouad (2000) state that over 90% of the construction firms have less than 10 employees. Therefore it is believed that there is an extra cost because of the fragmented functions within the team (Kumaraswamy, et al. 2005).

The industry is divided in silos of responsibility (Whaley 2009). Usually, the construction project is divided into work packages based on established specialized trades. Each work package is assigned to specialty designers and then to specialty contractors (Issa 2003) and design and construction phases are usually treated as separate activities (Baiden, et al. 2006). The creation of different professional groups and their associated working processes have helped to create fragmentation (Thomas 2004). As stated previously, within the construction project there are some major players, the owner, the design team and the construction team. However, those teams are also very fragmented and composed of different firms (Dulaimi, et al. 2004, O'Connor 2009); the design team is composed of architects, several engineers and other specialty consultants, while the construction team is composed of a general contractor and several layers of subcontractors and suppliers. Therefore, fragmentation exists not only within individual phases of the project development process but also across the different phases (Baiden, et al. 2006, CURT 2004, Dulaimi, et al. 2004, Mitropoulos and Tatum 2000, O'Connor 2009, Rahman and Kumaraswamy 2004).

Mitropoulos and Tarum (2000) suggest that there are two main causes for fragmentation, the first one is the complexity of projects and the second is the high level of specialization. Specialization results from the division of labor; it allows taking advantage of certain skills, but also fragments knowledge and goals (Mitropoulos and Tatum 2000). There is a belief that specialization would drive up efficiency; however it is causing fragmentation and is leading to a narrower focused research and development effort (Baiden, et al. 2006, Dulaimi, et al. 2002). The main causes of complexity are the amount of resources used, the level of knowledge required, the interactions of the different parts of the workflow, the number of technologies and their interdependence, the rigidity of the sequences of operations, the overlap of components of construction (Dubois and Gadde 2002), the environment (Dubois and Gadde 2002, Schwegler, et al. 2001), and the involvement of inputs from a multidisciplinary group of firms (Schwegler, et al. 2001, Tang 2001). These firms are organized in trades with several design consultants and subcontracting layers (Dubois and Gadde 2002), belonging to different cultural and geographic backgrounds. In this type of work setting, any change in time in any specialist's work could affect others part of work, and therefore could affect project duration and probably cost. An important issue is that projects are getting more complex and difficult over time, in a sense that have more systems interconnected in place (Chan, et al. 2004, Dubois and Gadde 2002).

As work is performed by different stakeholders who are not contractually responsible to each other, they do not have common goals to accomplish on the project (Omer Tatari 2009, Rahman and Kumaraswamy 2004, Thompson and Sanders 2008). Most of the time, the motivation for each project participant is the participants' own hidden or separate agenda (O'Connor 2009, Rahman and Kumaraswamy 2004); therefore there is competition instead of collaboration or coalescence (Thompson and Sanders 2008). In addition many stakeholders come on board very late in the process, therefore good ideas are usually held back (AIA National and AIA California Council 2007, Matthews and Howell 2005, O'Connor 2009). The contractual relationships are short term, based on the duration of the project, and success is not measured in terms of project outcomes, but instead is measured in terms of individual achievement, there is a need for local optimization sometimes at expenses of other parties and of the project as a whole (Matthews and Howell 2005, O'Connor 2009, Thompson and Sanders 2008), and there is not continuous improvement (Thompson and Sanders 2008). According to Knight (2008), it is very rare that two projects share designers, general contractors, subcontractors, suppliers, and even rarer that two projects share the design and construction team, owner, users and facility managers.

These challenges require a high level of coordination that most of the times is not accomplished (Matthews and Howell 2005, Mitropoulos and Tatum 2000). Coordination is required not only in terms of the project and its participants, but also in terms of each firm itself. Each firm needs to coordinate its activities and resources between all the projects in which the firm is involved (Dubois and Gadde 2002). However, that is difficult sometimes because of constraints in resources and because the roles of firms might vary in each project as they are specialized in one discipline (Dubois and Gadde 2002).

Because of the fragmented nature of the project there is a lack of exchange of information between the different parties. Several processes are repeated by different project members as information is not properly transferred and knowledge is not shared; creating waste of resources (CURT 2004, Issa 2003, Knight 2008, Luiten, et al. 1998, O'Connor 2007, Sun and Aouad 2000) and silos of knowledge, expertise (AIA National and AIA California Council 2007), and information (CURT 2004). In addition to the lack of information and knowledge exchange, the amount of information produced within a single project is enormous and it is very difficult to manage (Omer Tatari 2009); there are not clear standards for information exchange, storage and communication (O'Connor 2007, Sun and Aouad 2000); and there is inconsistency on the information generated for the project by different project participants (Sullivan 2009). CURT (2004) affirms that most of the difficulties experienced by the construction industry are because of the lack of cooperation and poor information integration. The fact that cross-disciplinary communication is very poor helps create a blaming culture that is now common in the industry (Sun and Aouad 2000).

Communication in Project Management

Communication between project participants is based primarily on drawings and specifications (usually paper-based) that use a 2D representation (AIA National and AIA California Council 2007, Froese, et al. 2000, Issa 2003). This type of communication often causes confusion and delays because it is very abstract and is subject to other parties' interpretation (Issa 2003), in addition, 2D drawings and specifications do not communicate critical relationships (Froese, et al. 2000). Therefore, teams spend too much time trying to understand project information instead of using information to solve problems and support the decision making processes (Froese, et al. 2000). In terms of the use of technology to aid in the design and construction of the project, computer programs are usually used by each specialty designer and each specialty contractor to aid in their own activities (Issa 2003) and this type of technology works adequately (CURT 2004). However, technology is not commonly used to its largest extent to integrate the project life cycle, including planning, design, construction and operation; and to properly transfer information among team members (Issa 2003, O'Connor 2007).

Building Information Modeling (BIM) presents great opportunities to provide information integration and has been used by some industry companies for the past two decades (AIA National and AIA California Council 2007, Eastman, et al. 2008, Kymmell 2008, Zuppa, et al. 2009). However, Froese et al. (2000) affirm that even though current software supports the representation of project information, it does not fully enable the exchange of different sources of information. In addition, often it is not possible to create a collaborative model because of legal implications (O'Connor 2007). On the other hand, the benefits of using this technology are not clearly stated for each stakeholder, therefore there is little incentive to acquire the technology (Schwegler, et al. 2001, Zuppa, et al. 2009). From the technical stand point, it is very difficult to enforce standardization of the design and construction tools, because as they evolve, they are optimized for a specific design or construction task. This is critical because it limits further the exchange of information, and the subsequent processes (Schwegler, et al. 2001).

There are several non-value adding activities that are related to inefficient information exchange and inoperability (Zuppa, et al. 2009). The US National Institute of Science and Technology states that inadequate interoperability costs the US building industry $15.8 billion annually (Batcheler and Howell 2005). In addition, according to Froese et al. (2000) during a project meeting, most of the time is spent on descriptive, explanative and evaluative tasks; and 10% of the time is spent on predictive tasks that can lead to better decisions. Most of these decisions are not taken in group settings because the information is not reliable and accurate, and is out of date. Therefore it is very difficult to actually predict the impact of one decision in the project.

Lack of Cooperation and Collaboration

In addition, fragmentation has prevented co-operation among project team members, and it has inhibited sharing knowledge. Even though some groups within the industry have had great achievements, those individual achievements have not helped the industry raise its standards (Tang 2001). As mentioned before, collaboration is not part of the construction culture (Mitropoulos and Tatum 2000), which is defined as a project culture (Rahman and Kumaraswamy 2004, Riley and Clare-Brown 2001); and is composed of a number of different sources that bring several culture components into play. Those components are: the organizational culture of each firm involved in the project, the operational culture, the individual culture, and the professional or trade culture (Kumaraswamy, et al. 2005, Rahman and Kumaraswamy 2004). This culture is highly influenced by the business environment (Riley and Clare-Brown 2001) and by barriers that currently exist between disciplines (Luiten, et al. 1998). Project participants speak different languages; therefore it is very difficult to understand the problems and needs of other project participants (Chan, et al. 2004, Dainty, et al. 2001, Koutsikouri, et al. 2008). In addition, adversarial relationships have been growing through the years creating a lack of trust between parties (Chan, et al. 2004, Dainty, et al. 2001), and a win-lose climate has become common within the entire industry (Chan, et al. 2004). Egan (1998) affirms that the behavior of construction participants is one of the greatest barriers to improvement.

Team Selection

An additional aspect that is preventing the industry to achieve its desired performance is the selection method of project participants. The traditional process is based on the belief that an owner benefits from choosing a different design and construction team for each project, primarily through competitive price selection (Dubois and Gadde 2002, Egan 1998, O'Connor 2007, Rooney 2006, Sun and Aouad 2000, Tang

2001). Thus, the relationships between project participants are usually short-term and cost-based instead of quality based (Chan and Chan 2004, Dubois and Gadde 2002, Luiten, et al. 1998). Dubios and Gadde (2002) affirm that in construction it is very rare for the same team to work in two different projects, and even if they do, they do it under different roles.

Price-based selection encourages bidders to drop their prices in order to win contracts. However, they rely on changes and claims to recover the real costs of the project (O'Connor 2009, Rahman and Kumaraswamy 2004, Zaghloul and Hartman 2003). Because of this, the traditional process has a large hidden cost that most of the times owners do not account for. For instance, the cost of increased claims and disputes; the cost of having a low quality contractor, which sometimes will have to be replaced; the cost of low final product quality and change order process (O'Connor 2009, Zaghloul and Hartman 2003); the costs of fragmentation between functions and of polarization (Kumaraswamy, et al. 2005); and the cost of not having innovation in the project (O'Connor 2007). O'Connor (2009) states that in year 2000, the average re-work in the construction industry was around 12%, accounting for approximately 17 billion dollars.

Inadequate Owner Involvement

Another concern in terms of causes for poor project performance is the participation of the owner. Most of the times there is not an adequate participation and involvement of the owner, because they have delegated the responsibility of directing the project to other parties (CURT 2004, O'Connor 2009). Therefore, the design team develops a design making many assumptions, and turns this design to the contractor, which oftentimes selects the means and methods of construction, thus the final product does not reflect the expectations and needs of the owner (O'Connor 2009). In addition, owners have not been assertive in demanding an improved way to deliver the project and have accepted the current practice as standard (CURT 2004).

Project-Based Short-Term Relationships and Lack of Knowledge Transfer and Training

As previously mentioned, work is site specific and project based (Dubois and Gadde 2002). There is a belief that each project is unique (Omer Tatari 2009), and that each project does not have a history or future (Dubois and Gadde 2002). Therefore there is a false belief that there is not room for transferring knowledge from one project to the other (CURT 2004, Sun and Aouad 2000). However, it has been suggested that 80% of the inputs are repeated from one project to the other (Sun and Aouad 2000), showing that even though the work is project based, knowledge and learning could be transferred if a non-traditional approach to project delivery would be implemented. Currently, project members bring to the project their individual experience and prejudices. After finalizing each project, the individual gains more experience but the learning process does not take place at the industry level because it is not transferred (CURT 2004, Dubois and Gadde 2002). In addition to the inability of transferring knowledge and learning between projects, there is also an inability to fully transfer knowledge between each project participant, because often, ideas are kept by each participant and participants are not aware of other participants' activities. As the transfer of knowledge is limited within the project, there is no innovation. Transferring aspects learned and knowledge from one project to the other and from one project participant to the other, takes place only in a very fragmented way (CURT 2004, Dubois and Gadde 2002).

Currently, because of the short term relationship, the compressed schedules and the price-based selection process, there is no incentive for firms working on one project to invest on teamwork skills building, innovation, technology, training, research and development, and education (Dubois and Gadde 2002, Dulaimi, et al. 2002, Egan 1998, O'Connor 2007, O'Connor 2009, Sun and Aouad 2000). According to Egan (1998) in the UK, research and development expenditures have fallen by 80% since 1981; the proportion of trainees has dropped by half since 1970s and there is a skills shortage in the industry. In addition of the short term relationship and the selection process, there are other issues responsible for the lack of research and development, training, and education; there is a lack of coordination between academia and industry in terms of research activities and education needs (Dulaimi, et al. 2002) and the contribution of the industry to research and development accounts only for the 0.5% of the industry's budget (O'Connor 2007). Dulaimi et al. (2002) affirm that low levels of research and development, innovation, education, training and team building in the construction industry are very important barriers that are preventing the development of the industry.

Traditional Contracting Structure and Risk Allocation

A very important cause of project fragmentation and poor performance is associated with the traditional contracting structure. Traditional contracts state responsibilities and also make important emphasis on consequences of failure and liabilities (Martin and Songer 2004, O'Connor 2009, Rahman and Kumaraswamy 2004, Skal 2005, Whaley 2009). Along with responsibilities, contracts define behavior but they do not breed commitment; their purpose is to protect one self-interest from other parties which are protecting their own self-interests even at others' expense (Martin and Songer 2004). Therefore they create a self-protective behavior from different team members, thereby building mistrust (O'Connor 2009, Thompson and Sanders 2008, Zaghloul and Hartman 2003), which in turn causes poor communication and conflict (Martin and Songer 2004). Additionally, they encourage team members to add a premium to their price in order to be covered for those clauses (O'Connor 2009, Zaghloul and Hartman 2003). Zaghloul and Hartman (2003) affirm that the cost of those premiums ranges from 8% to 20% and that the amount of the increase is inversely proportional to the trust between contracting parties.

Moreover, traditional contracts and project delivery systems produce sub-optimal results (O'Connor 2009), because they encourage unilateral efforts (AIA National and AIA California Council 2007). All of the above has created very adversarial roles between project members (Amor and Anumba 1999, Matthews and Howell 2005, O'Connor 2009, Rahman and Kumaraswamy 2004, Skal 2005, Tang 2001, Zaghloul and Hartman 2003) and has limited cooperation and innovation (Amor and Anumba 1999, CURT 2004, Matthews and Howell 2005, O'Connor 2009).

In addition, contract clauses are interpreted differently by each party for their own benefit (O'Connor 2009, Rahman and Kumaraswamy 2004). Zaghloul and Hartman (2003) affirm that approximately 74% of the contracts are written by the owner and are not negotiated. The spirit of current contracts goes in opposite direction to collaboration (Martin and Songer 2004), it erodes the construction process and its participants (Glagola and Sheedy 2002), and it enforces differences in values, goals and orientations that exist within the construction team (Dulaimi, et al. 2002).

Furthermore, contracts are means to transfer risk from one party to the other; thus in construction projects risk is not properly allocated, it is transferred to lower contracting tiers, which most of the times are less able to bear or control those risks (AIA National and AIA California Council 2007, O'Connor 2007, O'Connor 2009, Rahman and Kumaraswamy 2004, Thompson and Sanders 2008, Zaghloul and Hartman 2003). Contracts do not account for all the unforeseeable risks and for the fact that risks evolve throughout the project (Rahman and Kumaraswamy 2004). There is not an adequate risk management because with traditional contracts each party tries to minimize the costs of its own risks and to manage risk individually, instead of minimizing the total cost of risks in the project (AIA National and AIA California Council 2007, O'Connor 2009, Rahman and Kumaraswamy 2004). This is very important taking into consideration that construction risks can significantly increase the final cost of any project (Zaghloul and Hartman 2003).

Additionally, traditional contracts call for traditional approaches to dispute resolution, which are based on bringing outside experts (lawyers, arbitrators and mediators) to solve the problems. With this method, the actual issue or driver of the initial conflict is most of the times lost. The financial and personnel cost is huge but the greatest damage is caused by the disruption of the commercial relationships (Rooney 2006). There is a very high level of litigation within the construction industry, showing the enormous levels of mistrust (Martin and Songer 2004). Knight (2008) states that according to insurance companies and legal firms, many construction project failures are a consequence of poor communication and unmet expectations.

Reward Structure

The construction reward structure is also regarded as one of the causes for poor performance and industry fragmentation. The current reward structure does not encourage positive incentives for a good project (O'Connor 2009), individual success is not tied to the success of the project, and on the contrary it is just determined in terms of the achievement of individual firms. Therefore, project performance is not considered a parameter for work compensation (AIA National and AIA California Council 2007, Baiden, et al. 2006) and the industry is not benefiting from the quality and increased productivity that could result from real teamwork (Baiden, et al. 2006).

Subcontracting Structure

Another important issue associated to the lack of performance and project fragmentation is the subcontracting structure, whose proliferation has increased the fragmentation of the construction process (Dainty, et al. 2001). Subcontractors are the least tier of the construction process, and they are very influenced by their contracts, they are very self-protective and they try to optimize their own part of the project, creating very adversarial roles (O'Connor 2009). Additionally, the multi-layered subcontracting structure undermines the accountability in the project and results in poor site management, bringing problems of safety and environmental sustainability (Tang 2001).

Dainty et al. (2001) affirm that subcontractors and suppliers, in spite of being, who perform the actual construction, have very little managerial input. In addition to this, there is a lack of importance paid to them even in literature. Subcontractors and suppliers have a subordinate position in a very hierarchical relationship, resulting in several conflicts because all the responsibilities and liabilities are passed down to the next level. Thus, relationship between general contractors and subcontractors is very adversarial. Even if the general contractor or construction manager is selected through a negotiated contract, subcontractors are usually selected through a bidding process and many contractors accept the lowest bid, even knowing that the particular subcontractor is not the best value for the project.

Often subcontractors are not paid on time and there is a retention percentage from their payments, leading to cash flow difficulties. Therefore, sometimes subcontractors overcharge to be protected in cases of late payments (Dainty, et al. 2001). In addition, there are problems associated with programming. Usually subcontractors are required to perform their job in an unrealistic time, resulting in poor quality and late jobs (Dainty, et al. 2001, Tang 2001). Furthermore, sometimes subcontractors get to the jobsite and find out that they cannot perform their work because another party has not finished its own work. Another important problem in subcontractors' output is associated with the quality of information they receive; when they find gaps in design documents there is a reluctance to use the expertise of the subcontractor or the supplier to solve the problems. There is a belief that the current supply chain management process, based on several tiers of subcontracting, enhances general contractor profitability at the expense of others (Dainty, et al. 2001). Tang (2001) states that the fragmentation of the process leads to an inadequate management of site safety and environmental sustainability.

Project Delivery Methods

Traditional project delivery systems, such as Design-Bid-Build have segregated different team players; alternative delivery systems such as Construction Management, Design-Build and Supply Chain Management have created more collaborative environments and have improved project performance to some extent; however the traditional adversarial contractual relationship is still there (Martin and Songer 2004) and owners remain disappointed with project outcomes (Lichting 2005). Many practitioners have regarded Design-Build as a more integrated approach to project management, however, with traditional Design-Build projects, integration will not be achieved until the involvement of the owner is adjusted (O'Connor 2007, O'Connor 2009).

History of Construction Fragmentation

It is clear that the root of poor project performance is industry fragmentation. Therefore it is very interesting to understand the history that lags behind the fragmentation of the industry.

Since 1800 B.C. most projects were delivered using the concept of the master builder, who had absolute responsibility for the success or failure of the project. Later, during the industrial revolution, several changes on the structure of project delivery took place. The profession of Architects and Engineers emerged and the constructors were regarded as physical artisans. Therefore the roles were separated; designers' role was to reduce risk and to provide certainty that the project performed the intended function; on the other hand contractors were required to assume performance and cost risks, changing the culture within both roles. Later, increased specialization and technology increased the gap not only between designers and constructors, but within each role as well. For instance, the design discipline was fragmented between architecture, civil engineering, mechanical engineering and so on; roles taken by different firms and individuals.

Therefore, even within the design discipline, different firms perform some amount of work in isolation and compare their work at certain milestones (Lichting 2005).

Project Integration

To overcome most of the characteristics that are preventing the industry to achieve desired levels of performance improvement, the industry should change towards a more integrated approach to project delivery (Amor and Anumba 1999, CURT 2004, Dulaimi, et al. 2004, Egan 1998, Froese, et al. 2000, Kumaraswamy, et al. 2005, Mitropoulos and Tatum 2000, O'Connor 2009, Omer Tatari 2009, Rahman and Kumaraswamy 2004, Sun and Aouad 2000, Tang 2001).

In addition to achieving desired improvements in project performance, there are other drivers triggering the construction industry to move towards a more integrated approach in order to respond positively to the current sustainability, generational, cultural and market challenges. There is wide international competition, governments are supporting project integration, and there are enormous technological advancements that can support the change (Sun and Aouad 2000). Moreover, according to the participants of the A/E/C Integration Workshop, held at the Georgia Institute of Technology in 2007, projects are increasing in complexity, owners have greater expectations, performance measurements are now different from the traditional first cost approach (e.g., quality, sustainability, lifecycle cost, completion time), and the market is forcing collaboration. Additionally, owners are requesting more integrated solutions (i.e., resources are very limited so there is a need to improve productivity and efficiency), and there is desire by all project participants to reduce litigation.

Even though integration is recognized by many authors as the next step the construction industry needs to take, there are different approaches to integration. Biden et al (2006) define integration as the merging of disciplines and organizations which have different goals, needs and cultures into a mutually supporting and cohesive element. In addition, it encompasses the introduction of working practices, methods and behaviors to create a culture of efficient and effective collaboration among individuals and organizations. According to Fisher (1989) integration is the "continuous interdisciplinary sharing of data, knowledge and goals among project participants". Egan (1998) affirms that an integrated project process is "a process that utilizes the full construction team, bringing the skills of all participants to bear on delivering value to the client. It is a process that is explicit and transparent, and therefore easily understood by participants and their clients".

Kumaraswamy et al. (2005) identified two different approaches. The first one is focused on functional or structural integration, based on the integration of design and construction functions into one point of responsibility. And the second is focused on relational integration, based on the integration of the team and the supply chain. Kumaraswamy et al. (2005) affirm that it is evident that structural integration of functions and less rigid contracts is not enough, they are just a prelude to project integration and it is necessary to change the mind set and culture of the industry.

Current Advancements on Project Integration

Different authors and organizations have proposed different perspectives to study and to implement project integration. These perspectives are presented in the following subsections.

Integrated Project Delivery by the American Institute of Architects (AIA)

The AIA developed in 2007 a project delivery system based on an integrated project, called Integrated Project Delivery (IPD). It is a project delivery approach based on a collaborative process that integrates project participants, business structures, systems and construction practices, with the purpose of connecting and boosting project participants' talents and insights, optimizing project results, increasing value to the owner and other project participants, reducing waste, and raising efficiency throughout the project lifecycle. According to the AIA, this approach can be used with different contractual agreement structures (AIA National and AIA California Council 2007, Harness 2008). According to Khemlani (2009) the IPD concept is inspired by different delivery models explored in different parts of the world, especially project alliance.

According to AIA National and AIA California Council (2007) the principles of IPD are:

- Mutual respect and trust: key project participants should understand the value of collaboration and working as a team on the best interest of the project.
- Mutual benefit and reward: Incentives should be given according to the achievement of project goals.
- Collaborative innovation and decision making.
- Early involvement of key participants.
- Early goal definition.
- Intensified planning: teams should invest more time and effort in the first phases of projects in order to decrease conflicts during execution.
- Open communication: it facilitates defining each member's responsibilities, and changing the industry's blaming culture from determination of liability to resolution of problems.
- Appropriate use of technology.
- Organization and leadership.

In addition to defining the principles that must govern IPD, the AIA also proposed a change on the project phases from pre-design, schematic design, design development, construction documents, construction, close-out, and operation, to conceptualization, criteria design, detailed design, implementation documents, final buyout, construction, closeout, and operation. According to IPD the project is defined in the first three phases, project development is determined from the conceptualization stage to the final buyout, and construction takes place in the construction phase. With this approach, the owner, designer, design consultants and general contractor are brought into the project at the conceptualization stage, key trade contractors are brought in the design criteria phase, and trade contractors (who are not key participants) are brought until the buyout phase. While in the traditional project delivery method, the project is defined during the five initial phases. In the construction documents phase, stakeholders determine how to develop the project. In the bidding phase the contractor is defined, and in the construction phase the actual construction takes place. In the traditional approach the owner and designer are part of the project from pre-design, project consultants are brought in the schematic design or detailed design, the general contractor is brought in usually at the construction phase (and sometimes before to give some advice), and trade contractors are brought in during the construction phase (AIA National and AIA California Council 2007)

According to the AIA the most important changes that the industry needs to achieve in order to attain integration are the assembly of the project team in a collaborative manner, phasing the project as a flow from conceptualization through implementation and closeout, and moving all design decisions to the early process stages where they are more effective and less costly (AIA National and AIA California Council 2007).

IPD can be applied to any project delivery method with the exception of pure Design-Bid-Build. However, certain characteristics of individual project delivery methods will affect the degree of integration attained. Both Construction Management at Risk and Design-Build are better suited for integration, but neither will provide 100% integration if the definition of project team and phasing is not transformed (AIA National and AIA California Council 2007).

The major differences between the traditional project delivery (TPD) and IPD are that, in TPD, the team is fragmented and works together only when it is strictly necessary and this interaction is strongly hierarchical and controlled, whereas, in IPD, the team is formed by all key project stakeholders (i.e., facility managers, key subcontractors, vendors, etc., depending on the requirements of the specific project) early in the process within a collaborative framework. In TPD, the process is linear and segregated, knowledge exchange is used only when needed, information is kept private, and there are silos of knowledge and expertise. In IPD, the processes are concurrent and project participants contribute their knowledge and expertise to the team, information is open, and there is trust and respect within the team. In TPD, risk is managed by each firm and every stakeholder tries to transfer it to the largest extent, whereas, in IPD, risk is managed and shared by the team, placing responsibilities on the project participant best suited to handle it. In TPD, compensation is tied to the individual success based on first cost only, and each individual tries to maximize his return with minimum effort sometimes in detriment of the client or other participants. In IPD, the compensation is tied to the team successes and is not always evaluated just on a first cost basis, but also in terms of quality, sustainability, lifecycle cost, energy savings, schedule compliance, etc. depending on the project goals. In TPD, the contractual agreements foster unilateral efforts and are designed to transfer risk; in IDP, the contractual agreements support multilateral efforts and collaboration and promote risk sharing (AIA National and AIA California Council 2007, Matthews and Howell 2005).

The concept of IPD is starting to get momentum in the industry. There are some projects that have started to apply some of its principles, but there are few projects that are applying it to its largest extent (Khemlani 2009).

Khemlani (2009) developed a case study of one project that is using IPD, the Sutter Medical Center Castro Valley in California. It is a $320 million-dollar project, a state of the art 130-bed hospital. Sutter decided to use IPD because the large size of the project and the time and budget constraints. They decided also to use BIM as a multidisciplinary tool and to have a fully coordinated 3D model before construction started to have as less rework as possible. They used direct digital exchange, using the design model for estimation and fabrication. They eliminated handoffs, allowing an open flow of information. They allowed early and direct participation of fabricators. And they allowed real-time access to project members to all project information using Bentley's ProjectWise information management and document control application. Each team member used the BIM software which they had more experience with and better suited their needs, and periodic coordination meetings were held using NavisWorks. Estimating capabilities have not been used to the largest extent, because such functionality is more complex than they expected. They explored Solibri Model Checker for code checking, and deemed the program very promising but in need of further development.

They think that face to face meetings are critical for IPD; therefore they rented a facility near the project and team members met there at least biweekly, and the attitude and willingness to participate are essential to have a successful project. At the time Khemlani (2009) published this case study the project was at the end of the design phase. The structural design was reduced from 15 to 8 months and the design cost was below of what it was estimated.

Partnering

Partnering is a form of relational contracting based basically on a collaborative relationship between the owner and the contractor. Even though, it usually does not involve other stakeholders, this method gives the first approximation to project integration (Kumaraswamy, et al. 2005, Rahman and Kumaraswamy 2004).

Partnering tries to create an effective project management process between different organizations (Chan, et al. 2004). There are two main categories of partnering: the first one and most used is strategic partnering based on the long term commitment between two or more organizations; it is usually an arrangement where a contractor is engaged in a series of projects with the same owner in order to have business objectives together. The second one is single project partnering based on a collaboration environment on a project basis (Chan, et al. 2001, Dainty, et al. 2001, Glagola and Sheedy 2002, Thompson and Sanders 2008).

Some of the characteristics of partnering are the establishment of common goals, mutual trust, and taking into consideration expectations and values of project team members (Chan, et al. 2001, Thompson and Sanders 2008). It is based on the transformation of contractual relationships into cohesive and cooperative projects which have set goals and procedures to solve disputes in a timely manner (Chan, et al. 2001). And it offers an environment where an appropriate culture can be nurtured over several projects (Baiden, et al. 2006).

Different authors have provided the principles of partnering or the success factors for partnering. Following is a compilation on the different views and approaches to partnering. The compilation is not meant to be exhaustive; it presents a general overview of partnering approaches.

According to Chan et al. (2004) the principles of partnering are commitment, trust, respect, communication, and equality. Egan (1998) defines partnering principles as having mutual objectives, devising a way to resolve any disputes, committing themselves to continuous improvement, measuring progress, and sharing. And the core competencies of partnering according to Glagola and Sheedy (2002) are commitment, communication and conflict resolution.

Chan et al. (2004) developed a methodology to identify the significant factor for partnering success. They created a framework for research using literature review and then used a survey questionnaire, face to face interviews and detailed case studies to determine the significant factors. They used factor analysis to determine the success factors from the data collected through the survey questionnaire. The identified factors are:

- Establishment and communication of conflict resolution strategy.
- Commitment to a win-win attitude.

- Regular monitoring of partnering process.
- Clear definition of responsibilities.
- Mutual trust.
- Willingness to eliminate non-value added activities.
- Early implementation of partnering process.
- Willingness to share resources among project participants.
- Ability to generate innovative ideas.
- Subcontractor involvement.

Glagola and Sheedy (2002) did a compilation of the view of different associations and groups in terms of partnering. The following are the key elements for a successful partnering effort according to the Construction Industry Institute (CII):

- Formal process for partners or team selection.
- Team-building implementation plan.
- Defined objectives and criteria for partners or team selection.
- The partnering selection process plan and objectives and the team building plan should be clearly communicated to the organization.
- Development of a partnering agreement.
- Establishment of a team.
- Holding leadership workshops and training sessions.
- Team building should be an ongoing process.

In addition to the elements determined by the CII, the Associated General Contractors (AGC) also identified two additional elements as key to partnering (Glagola and Sheedy 2002):

- Equity of the stakeholders: they think that each party should understand the goals of each other and commit to considering those goals when making decisions on the project.
- Timely responsiveness.

The Army Corps of Engineers mentioned three other elements necessary for successful partnering (Glagola and Sheedy 2002):

- Elimination of adversarial relationships.
- Establishment of a partnering charter composed by a statement of the goals and objectives for the project and the mechanisms to manage conflict and dispute.
- Goals and objectives should be common to the project team.

The General Service Administration (GSA) uses partnering since 1994 in all construction projects in excess of one million dollars (Glagola and Sheedy 2002).

Thomson and Sanders (1998) affirm that the level of partnering achieved in a project depends on the degree of objectives alignment between the parties. According to their model, the partnering levels are cooperation, collaboration, and coalescence. They use the term partnering continuum to explain their model.

Thomson and Sanders (1998) define cooperation as achievement of agreements through compromise, collaboration as achievement of process improvements though teamwork, and coalescence as achievement of common objectives. Therefore, a project awarded through competitive bidding will not benefit from preliminary planning discussion, but it can have a cooperative approach up to some extent. Teams working on a single project in a cooperative environment can develop mutual objectives for the project by developing a team attitude and sharing information. The use of cooperation in this type of project results in reduced litigation and increased efficiency, in addition to an increase in mutual respect and trust. Benefits from single project partnering are usually just of cooperation. According to Thomson and Sanders (1998) the characteristics of cooperative work include:

- Project specific common objectives.
- Interpersonal relationships.
- Multiple points of contact.

- Team members that could potentially work on other projects.
- Limited trust and share risk guarding information sharing.
- Creation of a partnering charter to set the ground rules of the project.
- Time of responses set up front.

According to Thomson and Sanders (1998) if collaboration wants to be achieved, the different parties should focus not only in project goals, but also in long term improvements. Therefore, a strategic alliance should exist between the companies when they partner over a period of time. Open sharing of information should be ensured, as well openness, honesty and trust. Collaboration is relationship-dependent and it is important to monitor the relationship itself. The characteristics of a collaborative relationship include:

- Long-term focus and strategic goals.
- Multi-project agreement.
- Common system for measuring the project and the relationship tied to incentives.
- Improved process and reduced duplication.
- Shared authority.
- Increased risk sharing, openness, and honesty.

Coalescence is achieved when there is a complete alignment of objectives between parties; therefore it is possible not only to improve processes, but to redesign processes to achieve maximum benefit. Continuous improvement is achieved and complete trust exists. Coalescence is not a joint venture because it should be voluntary, it is pursued by separate organizations eliminating barriers and promoting teamwork. It is possible to form a separate entity which allows focusing on team objectives without organization boundaries. As team members see themselves as employees of the same organization, individuals are assigned to activities based on their skills. Reward programs should focus on the success of the project. The characteristics of coalescence include (Thompson and Sanders 1998):

- Common performance measurement system.
- Cooperative relationships, supported with collaboration.
- Integrated cultures.
- Transparent interface.
- Implicit trust and shared risk.
- Possible collocation of offices in a common location.

There are several benefits associated to the use of partnering. According to the AGC, partnering can result in increased profitability, because the owner will usually get the facility faster and the contractor will also get greater profits because of earlier completion and expedited decision making process. Lower tier subcontractors and suppliers will benefit because of earlier payments (Glagola and Sheedy 2002). There is elimination of redundant efforts, reduction in supervisory activities, and development of trust and mutual respect (Thompson and Sanders 1998). According to Chan et al. (2004) partnering lowers the risks of cost overruns and delays, and improves the opportunity for innovation in terms of value engineering and constructability. They presented results of research where they found that 73.3% of partnering projects were on schedule or ahead of schedule, 82.9% were in budget or under budget, 86.7% had less disputes than an average project, 86.8 had less claims than an average project, 90.9% of the participants were moderately to high satisfied with quality, and 78.2% were happy with the working relationship.

The benefits of partnering increase as the relationship between the parties increase. And it cannot even bring any benefit and it will fail, if it is not applied in a proper way. In order to increase the relationships between the parties it is necessary to accept uncertainties and be vulnerable, and it requires commitment and effort from all parties involved (Glagola and Sheedy 2002, Thompson and Sanders 1998).

Partnering will not solve all construction problems, it is not a formula that guarantees a fix, is more a philosophy that should be used depending on the characteristics of the project (Glagola and Sheedy 2002, Thompson and Sanders 1998). The manner of partnering depends on the project objectives, the resources available, and the length of commitment desired (Thompson and Sanders 1998).

There are some researchers like Lichtig (2005) and Dainty et al. (2001) who affirm that industry proven solutions such as partnering do not address the fragmentation problem at its roots; they just mitigate the negative impact of the problems. There are some partnering agreements that still lead to mistrust and conflict between the owner and the contractor because of the quasi-competitive control methods. In addition most partnering efforts are between the owner and the general contractor. It is very uncommon for subcontractors or suppliers to be involved in this type of agreements. In order to realize the real benefits of partnership it is necessary to involve the entire supply chain from suppliers to the final user (Dainty, et al. 2001).

Construction Supply Chain Integration by Dainty et al.

As presented previously, Dainty et al. (2001) state that the main concern with partnering is that it is an agreement between the owner and the general contractor; thus it does not integrate the project supply chain. They affirm that integrating subcontractors and suppliers as key players of the project is essential to achieve truly integration. Therefore, they conducted research to find the barriers to supply chain integration for subcontractors and possible solutions.

They interviewed staff from general contractors, subcontractors and suppliers. Then they conducted some focus groups to refine a set of requirements for improving integration. In terms of financial issues, they found that the main barriers to integration are late and incorrect payments, the bidding process and the withholding of final payments. Therefore, to attain integration, fair payment for subcontractors is necessary, it is important to focus on value instead of price and to build trust.

In terms of programming, the main barrier is related to unrealistic program times; therefore all parties should be involved early in the process. In terms of the contracting structure, the main barrier is that "current contract" does not encourage good working relationships, therefore new contracts or less reliance on contracts are needed. In terms of the general contractor staff, the main barrier is that project managers do not encourage subcontractor integration and estimators are too demanding on small organizations. Therefore, team members should be trained in communication skills, general contractors need to be educated on the business needs of smaller organizations, and estimators should be educated on the work subcontractors need to do in order to get a project done.

In terms of knowledge and information, the main barrier is that companies do not understand others' business within the supply chain; so it is important to allocate time to learn about other members' organization. In terms of partnering or integration, the barrier is that the core group excludes some project participants such as subcontractors and that subcontractors lack design, legislation, and costing skills that are required to be part of the team; making it important to educate all project participants on the benefits of integration; in addition, benefits have to be offered to the entire team and subcontractors need to be trained on their lacking skills.

Dimensions of Project Integration by Biden et al.

Biden et al. (2006) developed a model to define the different dimensions of project integration and for each dimension they state the different characteristics that make the project fully integrated, partially integrated or non-integrated. The different dimensions and their characteristics are presented in Table 1.

Table 1- Dimensions of Project Integration and Their Characteristics According to Biden et al. (2006)

Dimensions	Fully Integrated	Partially Integrated	Non Integrated
Single team focus and objectives for the project	All members work towards team objectives	All members pursue individual objectives but are in line with the project objectives	Objectives are individual and are isolated to others and project objectives
Operation without boundaries between the different organizations	Team members form a new single project team with no boundaries or individual member identity	All members operate as individuals, but make an effort to collaborate	Individuals are affiliated and aligned to individual organizations that composed the team
Mutually beneficial outcomes and shared achievements by the entire team	The project goals benefit all members	Project goals are attained with other members whose involvement are necessary	Individual objectives are defined without compromise to other
Increased prediction of time and cost because it utilizes the skills and expertise of all parties	Design and construction cost information is open	Systematic follow up of design and construction cost	Disjointed design and construction costs information
Free information share among team members	Information is available and all parties have access to all information	Access to project information is limited to a section or sections of the project team	Information is just available to people in that particular section of work
Flexible team composition able to respond to change over the duration of the project	People join and leave the project on the basis of the requirement of their skills	Team members who are no longer required, are trained to fulfill new requirements	Team members are used even when they had outlived their effectiveness
Single relocated to a common space team	Single project team that is located in a single location	Different sub teams which are located in a single space	Team members work in different teams and different locations
Equal opportunity for project inputs	Team members are consulted before decisions are made	Ideas and contribution are welcome, but are not required as part of the decision making process	Opinion of team members is not taken into consideration as part of the decision making process
Equitable team relationships and respect for all	All team members are treated with respect and as capable of performing the work for the project.	There is recognition of professional competence, but just in their respective fields	Team members contribution is limited to their field
No blame culture	Problems and conflicts are identified and solved collectively, and the project outcomes are responsibility of the team	There is cooperation in order to solve problems; however the responsibility is remains on one party	Problems are solely responsibility of each party

Factors Required to Achieve and Integrated Design Team by Koutsikouri et al.

Koutsikouri et al. (2008) identified four categories of factors that should be in place to achieve an integrated design team. The categories and attributes that compose each category are presented in Table 2:

Table 2- Categories and Attributes of an Integrated Design Team by Koutsikouri et al. (2008)

Categories	**Attributes**
Management Issues	Defined project goals, defined roles and responsibilities, project management practices, quality of leadership, management of expectations, feedback on progress and commercial awareness.
Design team issues	Shared project vision, team selection and composition, team building process, interdisciplinary teamwork, creativity and innovation, relationships, mutual trust and understanding, and sufficient resources.
Competencies and resources	Technical skills, social skills, flexibility, time management, and appropriate technologies.
Project enablers	Rich communications, passion and enthusiasm, recognition, motivation, organizational structure, culture, knowledge sharing, client focus, physical work environment, and shared values.

Koutsikouri et al. (2008) affirm that each factor has an influence on the others, so it is possible to explain each factor by itself, but it is important to understand the influence of each factor on the others.

Integrated Design Process by the British Columbia Green Building Round Table

According to (Busby Perkins and Will and Satnec Consulting. 2007) The British Columbia Green Building Roundtable developed the Integrated Design Process (IDP), whose main objective is to achieve sustainable buildings. It is based on the work of a multidisciplinary collaborative team, who has a holistic understanding of the project and exert a collaborative decision making process. The focus of the IDP is on design, construction, operation and occupancy of the building. The IDP is based on a change of mindset, a set of principles, and some strategies to achieve them. The mindsets, principles and strategies of the IDP are presented in

Table 3.

Table 3- Mindset, Principles and Strategies of the Integrated Design Process

Mindset	Principle	Strategies
Inclusion and collaboration	Broad collaborative team	Careful team formation
Outcome oriented	Well-defined scope, vision, goals, and objectives	Team building
Trust and transparency	Effective and open communication	Facilitation training for team and expert facilitation
Open-mindedness and creativity	Innovation and synthesis	Visioning charrettes and brainstorming
Rigor and attention to detail	Systematic decision making	Goals and targets matrix and decision making tools
Continuous learning and improvement	Iterative process with feedback cycles	Post occupancy evaluation and comprehensive commissioning

<u>Achievement of Greater Levels of Integration by Dulami et al.</u>

Dulami et al. (2002) conducted research to identify how the industry can achieve greater levels of integration and increase its research and development efforts. They conducted a survey and an industry workshop. Their findings were:

- It is necessary for risks, responsibilities and benefits to be clear to all organizations involved in the project.
- There must be a culture of win-win attitude.
- Clients and specialty contractors should play a very important role in the project
- Specialty contractors should be involved early in the process and should play a greater role.

<u>Integrated Agreement for Lean Project Delivery</u>

Lichtig (2005) affirms that partnering does not attack the root of fragmentation; therefore he proposed a model that combines lean project delivery and project integration, called Integrated Agreement for Lean Project Delivery. His model is based on the following five ideas:

- Collaborate through design, planning and execution of the project in order to maximize positive interactions and minimize negative interactions. If the entire team is collaborating early in the process, the knowledge of other participants will be included in positive iterations, and late changes or negative iterations will be reduced.
- Increase relatedness among all project participants. It is important to develop relationships based on trust and "share their mistakes as learning opportunities for their project and all other projects".
- Projects are networks of commitments.
- Optimize the project not the pieces, because optimization at the task level increases local performance, but complicates coordination, reduces trust and can increase project duration.
- Tightly couple action with learning, thus continuous improvement in terms of cost, schedule and project value can be achieved.

Factors Affecting Integration by Mitropoulos and Tatum

Mitropoulos and Tatum (2000) created a model of factors affecting integration that is composed of the following characteristics:

- Business environment factors such as uncertainty, complexity, and speed determine project integration requirements.
- The degree of integration depends on contractual, organizational and technological mechanisms.
- Project performance depends on the match between required and actual integration.

- Company performance and competitiveness is affected by project performance.

Attributes that Affect the Success of Integration

Many authors have defined different attributes or principles that should be taken into consideration in order to achieve project integration. 41 of those attributes are described in the following paragraphs; the order in which they are presented does not have any relationship with the importance of those attributes toward achieving successful integration.

Adequate Risk Management:

Adequate risk management has been identified by several authors as an important factor for project integration (Bedrick, et al. 2006, Chan, et al. 2004, CURT 2004, Dulaimi, et al. 2002, Kumaraswamy, et al. 2005, Lichting 2005, Matthews and Howell 2005, O'Connor 2009, Rahman and Kumaraswamy 2004, Rooney 2006, Skal 2005, Sullivan 2009, Tang 2001, Thompson and Sanders 2008, Zaghloul and Hartman 2003). It is important to establish a risk sharing structure and to have adequate risk management, whose main goal should be to minimize the overall project risk instead of shifting the risk from one party to the other (Chan, et al. 2004, Lichtig 2005, O'Connor 2009, Zaghloul and Hartman 2003). Equitable risk allocation can help to improve the behavior of the team and the relationships among each other (Skal 2005, Tang 2001, Zaghloul and Hartman 2003).

Risk can be managed though appropriate language on the contract (Skal 2005, Zaghloul and Hartman 2003). In addition, it can be minimized when the entire team is on board early in the process and there is no ambiguity on the construction documents (Lichtig 2005).

Depending on the level of integration, risk management should evolve. If there is very limited integration, there should be a limited shared risk. Projects with higher degree of integration have an increased risk sharing, while completely integrated projects should have implicit shared risk (Thompson and Sanders 1998).

<u>Internal Dispute Resolution</u>

To have an internal strategy of conflict and dispute resolution is fundamental to attain integration (AIA National and AIA California Council 2007, Chan, et al. 2004, Glagola and Sheedy 2002, Kumaraswamy, et al. 2005, Lichtig 2005, Mitropoulos and Tatum 2000, Rahman and Kumaraswamy 2004, Rooney 2006, Tang 2001). Conflicts are common in the construction industry, they usually arise from the discrepancy in goals and expectations among parties (Chan, et al. 2004). In order to avoid conflicts before they arise and to reduce disputes, it is very important to set common goals and objectives, to understand other party's goals, to have an open communication, to eliminate the blame culture, to establish dispute resolution mechanisms up front, and to solve the problems in a timely basis (AIA National and AIA California Council 2007, Glagola and Sheedy 2002, O'Connor 2009, Skal 2005).

Coercion and confrontation are counterproductive, therefore joint problem solving should be used by looking for mutually satisfactory solution and seek alternatives for problematic issues (Chan, et al. 2004). There are two main approaches to internal conflict and dispute resolution. The first one is to appoint a decision making body for the entire team composed of individuals from all parties that is responsible for solving all conflicts (AIA National and AIA California Council 2007, Rahman and Kumaraswamy 2004, Tang 2001). The second one is the forced escalation of the conflict. According to Glagola and Sheedy (2002) in many partnering projects a prevention mechanism, called "forced escalation" is developed. This mechanism is based on giving a specified amount of time to each working level when a dispute arises. If when time expires the dispute has not been solved, it is sent to one management level up. At this level there is also a fixed amount of time to solve the dispute. If it is not resolved in the allocated time it will be forwarded to the next higher level until it gets to the chief executive officer (CEO) level of the organizations involved. The CEO level also has a set time to solve the dispute before it goes to arbitration or mediation as final mechanisms.

Performance Oriented Culture

Another important aspect for project integration is that the project culture should evolve towards a performance oriented culture based on values and principles whose aim should be to provide better value to the customer and to foster continuous improvement (Egan 1998, Knight 2008, Kumaraswamy, et al. 2005, Lichtig 2005, Rahman and Kumaraswamy 2004, Rooney 2006, Tang 2001, Thompson and Sanders 1998, Busby Perkins and Will and Santec Consulting 2007). In order to sustain a performance oriented culture, continuous performance measurement are required against clear targets of quality, timeliness and cost (Egan 1998, Kumaraswamy, et al. 2005).

Mutual Respect and Trust

Mutual respect and trust are essential to work together as a team in the best interest of the project (AIA National and AIA California Council 2007, Baiden, et al. 2006, Chan, et al. 2004, Dainty, et al. 2001, Egan 1998, Glagola and Sheedy 2002, Knight 2008, Koutsikouri, et al. 2008, Kumaraswamy, et al. 2005, Lichting 2005, Martin and Songer 2004, O'Connor 2009, Rahman and Kumaraswamy 2004, Skal 2005, Tang 2001, Thompson and Sanders 2008, Whaley 2009, Busby Perkins and Will and Santec Consulting. 2007, Zaghloul and Hartman 2003); thus people know what to expect when working with other people (Martin and Songer 2004)

Martin and Songer (2004) affirm that “trust is developed from the right thing being done” and that “it is a psychological state to accept vulnerability based on the expectation that the intention of another is reciprocated positively". Therefore, when expectations are met over and over and each party knows that others are reliable in fulfilling their obligations trust is developed (Chan, et al. 2004, Martin and Songer 2004). As a result reputation is very important in order to build trust because if the different parties are sure of the capabilities of other parties, they believe the other parties will do their job in the best way possible (Kumaraswamy, et al. 2005).

Zahloul and Hartman (2003) affirm that with the absence of trust it is very difficult to achieve successful project relationships because they will only be governed by the contract documents as a control mechanism. They state that there are different levels of trust, and with higher levels the project outcome will be improved. The first level of trust is defined as competence, which is based on the perception that the other is able to perform what is required. The second level is integrity, which is based on the perception that the other will act ethically and will not take advantage on the other party. And the third one is intuitive. The classification of trust made by Zahloul and Hartman (2003) is very similar to the thought of Thompson and Sanders (1998) in regard to trust and the degree of integration. Thomson and Sanders (1998) affirm that trust is developed depending on the degree of integration. In a project with limited integration there is limited trust, in a project with a greater degree of integration there is honesty and certain degree of trust. In a completely integrated project trust should be implicit (Thompson and Sanders 1998).

Not only trust, but also mutual respect, ethics, honesty, no blame culture, equitable relationships atmosphere, and fairness are essential characteristics that every team member should have to achieve integration (Baiden, et al. 2006, Tang 2001). AIA National and AIA California Council (2007) affirm that even though the IPD project promises better outputs, these will not be realized until people involved in the process change.

Clear Benefits for all Members Involved

In order to have the whole team committed to the integration process it has to be a process that benefits all parties in the supply chain (AIA National and AIA California Council 2007, Baiden, et al. 2006, Dainty, et al. 2001, Dulaimi, et al. 2004, Egan 1998, Lichtig 2005). The success of the project should be shared by the entire team, in line with the value they add. Thus the owner should not take all the benefits; all team members should make fair returns as well (Egan 1998). In addition, it is very important that benefits of the integrated process are clearly stated upfront to all team members involved (Baiden, et al. 2006).

According to the AIA National and the AIA California Council (2007) one of the benefits anticipated to the project members is that the owner should benefit from an integrated process because it will be more informed of the options and will be able to balance them to meet its goals. In addition to this, the project team will better understand the owner requirements and will be able to meet project goals in terms of schedule life cycle cost, quality and sustainability. From the construction team perspective, the project members will better understand the project in a timely manner; therefore design related issues will be solved. In addition, construction team members will be able to improve cost control and budget management. From the design team perspective, designers will benefit from the early contribution of the construction team. In addition, their participation resolving design issues during construction will be reduced. However greater benefits should exists in terms of monetary return to the construction team and the design team (Dainty, et al. 2001, Egan 1998).

Training and Education

In terms of training and education and their impact on integration several authors recognize that they play an important role (Dainty, et al. 2001, Egan 1998, Glagola and Sheedy 2002, Kumaraswamy, et al. 2005, Mitropoulos and Tatum 2000, O'Connor 2007, Tang 2001). In spite of different perspectives on their role, there are some authors who think that training and education should be used to develop a broader set of skills that allow interacting in an integrated environment (Egan 1998, Glagola and Sheedy 2002, Kumaraswamy, et al. 2005, Mitropoulos and Tatum 2000, O'Connor 2007, Tang 2001). Kumaraswamy et al. (2005) found that training on the different skills is important, but workshops for team building and trust building are not very effective. On the other hand Mitropoulos and Tatum (2000) affirm that it is important to train the team in teamwork. Lichtig (2005) affirm that in addition of training the project participants in the required skills, it is necessary to generate a learning environment within the team. Egan (1998) states that the type of training and education required depends on the role of the person as part of the team. He says that at the top management level a balance of technical and leadership skills are needed; therefore training leaders of excellence is required. At the project manager level, training should be based on integrating project and leading performance improvement. On the other hand designers should be trained to better understand the needs of the clients and the industry.

Innovation and Innovative Thinking

It is very important for the entire team to have an innovative thinking, to stimulate innovation, and to have an open mind to accept others ideas to reach optimized solutions of an integrated project (AIA National and AIA California Council 2007, Chan, et al. 2004, Koutsikouri, et al. 2008, O'Connor 2007, Rooney 2006, Skal 2005, Sun and Aouad 2000, Busby Perkins and Will and Santec Consulting 2007). Innovation is encouraged when ideas can be freely exchanged and when ideas are not evaluated according to the role of the person in the project (AIA National and AIA California Council 2007, O'Connor 2007, Skal 2005). When there are creative processes it is easier to satisfy the design requirements (Koutsikouri, et al. 2008). In addition to this it can be used as a tool to reduce costs by finding new ways to do things (Chan, et al. 2004).

Early Involvement of Key Project Participants

A fundamental aspect of project integration is early involvement of key project participants, because it improves the input of knowledge and expertise in the early stages of the process, when decisions are less costly and more effective (AIA National and AIA California Council 2007, Bedrick, et al. 2006, CURT 2004, Dainty, et al. 2001, Dulaimi, et al. 2002, Egan 1998, Koutsikouri, et al. 2008, Kumaraswamy, et al. 2005, Lichtig 2005, Lichting 2005, Mitropoulos and Tatum 2000, Tang 2001, Busby Perkins and Will and Santec Consulting 2007). However, there are differences in the perception of who should form the group of key project participants. Most authors coincide that the key participants at least are the owner, the architect and the contractor. However, there are some authors who explain the importance of involving the subcontractors and specialty contractors and the user or facility manager since the inspection of the project.

For instance, according to the AIA National and AIA California Council (2007), the team should be formed by the primary participants, the ones that have substantial involvement from the beginning to the end: the owner, the architect and the contractor; and the key supporting participants. The assignment of these groups depends on a project to project basis. Busby Perkins and Will and Santec Consulting (2007) state that usually the core project team members should be the owner, project manager, architect, a facilitator, structural engineer, mechanical engineer, electrical engineer, green design specialist, civil engineer, facilities manager, cost consultant, landscape architect and general contractor or construction manager. They affirm that this team can vary depending on the needs of the project. Therefore, this section does not pretend to define who are the key project participants, because other sections deal with the involvement of subcontractor, suppliers and facility managers. This section attempts to explain when the team of key project participants should form.

The main reason for having the team involved early in the project is that technical expertise is the foundation for creative design and it depends on what happens at the early stages of planning and design. It is on those stages that team members other than the Architect have the opportunity to influence the architectural design (Koutsikouri, et al. 2008). Therefore, all building systems should be designed concurrently with the architectural design and should be integrated taking as a basis the design intent (CURT 2004).

It is very important to differentiate between integration and preconstruction services. Integration goes beyond commenting on the work of another professional, doing a constructability analysis and performing value engineering (O'Connor 2009).

Team Building and Teamwork

In addition to involving the right team at the right time Tang (2001), Kumaraswamy et al. (2005), Sun and Aouad (2000), Baiden et al. (2006), Koutsikouri et al. (2008), Chan et al. (2004), Busby Perkins and Will and Santec Consulting (2007), Dulami et al. (2002), Glagola and Sheedy, Kumaraswamy et al. (2005), Lichtig (2005), Mitroupolos and Tatum (2000), Thompson and Sanders (1998), O’Connor (2009), Rahman and Kumaraswamy (2004), Rooney (2006), and Whaley (2009) explain that truly building a team and promote teamwork is essential to achieve the best project outcomes; because as O’Connor (2009) states: “Teamwork produces optimal results in nearly all fields of human endeavor”.

Just putting the team together does not fix the problem, because bringing individuals together from different backgrounds for a task will not automatically generate teamwork, since each of the stakeholders speaks different languages and usually does not understand the problems and discipline of the other (Koutsikouri, et al. 2008, Whaley 2009). In order to achieve integration, it is important to think of teams as interdisciplinary instead of multidisciplinary endeavors. A multidisciplinary team implies that there are several disciplines involved in the project, while in an interdisciplinary team problems should be solved by the team as a whole and team members should contribute beyond their professions (Koutsikouri, et al. 2008). According to Glagola and Sheedy (2002) "successful teams are built on the strengths of each member, while successful lawsuits are founded on capitalizing on the weakness of team members".

Teambuilding depends on four characteristics primarily. Most authors coincide on the three first ones, and there is some discrepancy on the fourth one. The first important characteristic is the interaction between individuals because each individual brings a set of teamwork skills and social skills to the project, and when individuals cannot work in an integrated environment they should be removed from the project (Koutsikouri, et al. 2008, Whaley 2009). Second is the team environment in work on a daily basis, it is necessary to build a team through the development of mutual trust, enthusiasm, appreciation, effective communication, respect, the ability to use conflict in a constructive and positive way to ensure best ideas are identified, commitment, accountability, and results (Chan, et al. 2004, Lencioni 2002, Whaley 2009). The third one is to identify common goals and upfront agreement on the decision making mechanisms (Chan, et al. 2001, Whaley 2009). And finally the fourth one is to have facilitated teambuilding exercises. Whaley (2009) explains that it is essential to develop a facilitated team building exercise with the participation of the entire team, and that the effort should continue after the exercise, but on the other hand Kumaraswamy et al. (2005) found that team building workshops are not very effective.

Kumaraswamy et al. (2005) found that the three most important factors in order to build integrated teams are: to disclose all project information to all team members early in the process in order to get feedback from them; second, to have previous records of team members on soft factors such as joint decision making and joint problem solving among others; and the third is the reputation of the team companies in the industry, because greater reputation is directly linked with greater trust. If the different parties are confident of the capabilities of each other it is easier to build trust. Additionally, it is very important to have a joint risk management plan and a joint problem solving strategy.

They found that the least important factors were workshops to educate on trust and reliability, and on the integrated practice and the use of an external facilitator.

Teambuilding is an effort that has to start as early as possible in the project lifecycle in order to create real trust and respect. And having a good team is meant to improve communication, knowledge sharing, team bonding and getting the project members enthusiastic about the project (Koutsikouri, et al. 2008).

Team Selection Criteria and Procedure

As Knight (2008) states: “the single most important action an owner can take is to pay great attention to detail in team selection. Picking the right team is, above all else, the key to great success”. Therefore it is essential to change the team selection criteria from solely cost-based to include other relevant criteria for project integration and project success (Dainty, et al. 2001, Egan 1998, Glagola and Sheedy 2002, Knight 2008, Koutsikouri, et al. 2008, Lichtig 2005, O'Connor 2009, Rahman and Kumaraswamy 2004, Skal 2005, Busby Perkins and Will and Santec Consulting 2007).

A truly integrated project brings important risks to the team and especially to the owner, because the project is built on relationships and trust. It relies on the behavior of the project team in order to be successful, and if one party does not perform as required, then the process will not be successful. This is the most important reason for selecting the right team and not using a price based selection (O'Connor 2009). In addition, there will not be any contract clauses that can cover these risks; according to O’Connor (2009) “No contract, whether based on traditional or relational concepts, can save one after making the wrong choice with whom to collaborate”.

The bidding process goes in an opposite direction as integration. According to Dainty et al. (2001) in order to attain effective integration, the competitive bidding process has to change as the method for contractor selection (as sometimes is done), and as the method for subcontractor selection (as is usually done). According to Egan (1998) the industry needs to change the bidding process to a process based on long-term relationships built on performance measurements and continuous improvements in quality and efficiency. O'Connor (2009) and Skal (2005) suggest that cost related conversation, should take place only after the team has been selected.

The team should be selected according to qualifications, previous experience, the ability and commitment to participate in an integrated team, their willingness to commit to shared-risk ideas, open communication and creation of no-blame culture, they should be good communicators, they should have a cooperative attitude, and be open-minded (O'Connor 2009, Skal 2005, Busby Perkins and Will and Santec Consulting 2007). Moreover, owners should select team members that can demonstrate the use of trained workers, with a teamwork attitude and the ability to innovate and offer efficient solutions (Egan 1998). Because as O'Connor (2009) stated it: "Not everyone can successfully perform within an IPD environment".

Skal (2005) proposes an eight-step process to select the team: invite proposals; receive proposals; assess capabilities, suitability and commit to project integration; establish short list of proponents; interview proponents on the short list; reduce the list of proponents to two; set up a workshop with each proponent to determine principles, commitment to outstanding results, and the composition of the project management team; and finally, select consultants and contractors. After the consultants and contractors are selected, the cost of the work should be fixed.

According to Egan (1998) the most immediately accessible savings that are currently accounted by partnering and alliances are because the bidding process is reduced. One of the main concerns of owners is the value they are going to get if they do not use bids as a selection mechanism; in order to address this concern it is necessary to keep track of the performance of contractors and suppliers and to have clear measurements of their performance. In addition to this, having an open book accounting is necessary for the owner to know how its money is being spent.

Collaborative Decision Making

Collaborative decision making is very important for project integration because ideas should be evaluated by the project team and consensus should be encouraged. Decisions should be made with knowledge of the different facts and points of view to make the best decisions in the best interest of the project and to minimize any type of failure (AIA National and AIA California Council 2007, Baiden, et al. 2006, Kumaraswamy, et al. 2005, O'Connor 2009, Rooney 2006, Skal 2005, Thompson and Sanders 1998, Whaley 2009, Busby Perkins and Will and Santec Consulting 2007).

As in every project there are going to be minor decisions that do not affect the project outcome that can be made individually, however, key decisions should not be made without the entire team input (Busby Perkins and Will and Santec Consulting 2007).

Intensified Planning

The greatest effort should be placed in the planning phases because it is very important to shift most of the analysis and decision making to early in the process. This is where there is greater opportunity for more cost effective decisions with better financial impact. Early decisions are less costly and more effective as seen in Figure 1 (AIA National and AIA California Council 2007, CURT 2004, Lichtig 2005, Mitropoulos and Tatum 2000, Rahman and Kumaraswamy 2004, Tang 2001).

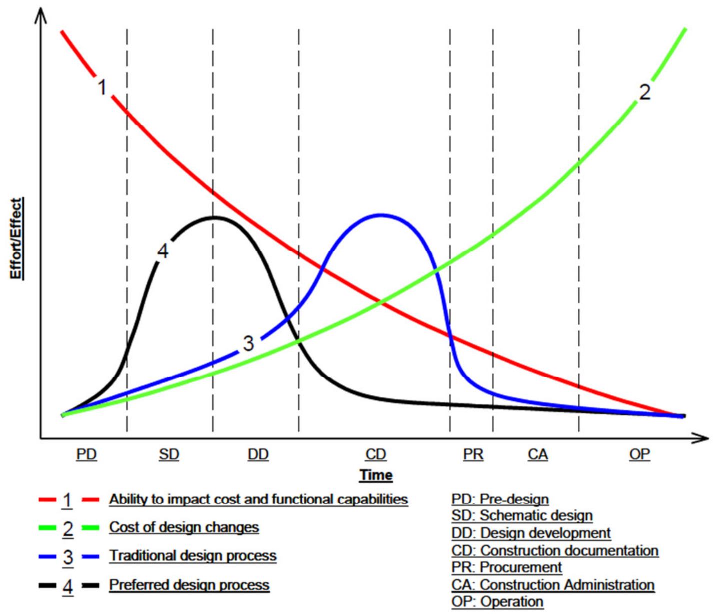

Figure 1- Relationship of Effort and Effect Depending on Phases of the Project. Extracted from CURT (2004)

An analysis of several design strategies early in the project and a good understanding of the implications of selecting one, helps stabilize the project and helps make informed decisions in a timely manner (CURT 2004). In addition to this, if the project is completely defined before construction starts, then the construction process that is more expensive will be streamlined (AIA National and AIA California Council 2007, CURT 2004, Mitropoulos and Tatum 2000, Rahman and Kumaraswamy 2004, Tang 2001). Therefore, all the agreements should be developed and should start before the design phase starts (Chan, et al. 2004).

Early Goal and Objectives Definition

In the planning stage it is very important to understand, to agree on, and to set the project goals and objectives early in the process, because when goals are ambiguous or not well understood by all team members, the outcomes will not reflect what the project expects (AIA National and AIA California Council 2007, Glagola and Sheedy 2002, Koutsikouri, et al. 2008, Lichtig 2005, Rooney 2006, Thompson and Sanders 2008, Busby Perkins and Will and Santec Consulting 2007). Therefore, goals should be clear to all project members (Koutsikouri, et al. 2008), and objectives should be realistic, because otherwise team members will not be motivated to pursue them and will create adversarial relationships (Chua, et al. 1999).

Reward Structure Linked to the Success of the Project

The reward structure should link the financial success of each project member to the success of the project (AIA National and AIA California Council 2007, CURT 2004, Egan 1998, Lichtig 2005, Mitropoulos and Tatum 2000, Rahman and Kumaraswamy 2004, Rooney 2006, Skal 2005, Tang 2001, Thompson and Sanders 1998, Busby Perkins and Will and Santec Consulting 2007); This approach should take into consideration participants instinct to protect their own financial benefit (AIA National and AIA California Council 2007).

Team members should not be penalized when they have ideas that would bring value to the project, design fees should never be calculated in terms of percentage of project cost, because there is no incentive to build efficiently (Egan 1998, Busby Perkins and Will and Santec Consulting 2007, Yeung, et al. 2007). Busby Perkins and Will and Santec Consulting (2007) present an example: the mechanical design fee should not be linked to the mechanical budget as a percentage. Otherwise it is very difficult for designers to propose new systems that might reduce the size of the mechanical equipment.

It is essential for each party to recognize that they are going to succeed if the performance of other team members is successful (Lichtig 2005). Therefore, project participants should work together in a spirit of collaboration and mutual respect, with the benefits of the project in mind, to achieve common objectives and common goals (Glagola and Sheedy 2002, Lichting 2005, Martin and Songer 2004, Rahman and Kumaraswamy 2004, Tang 2001, Thompson and Sanders 2008). Lichtig (2005) affirms that it is important to include an incentive sharing plan based on project performance.

Appropriate Use of Technology

Technology should be properly and more extensively used in order to achieve project integration (AIA National and AIA California Council 2007, Bedrick, et al. 2006, CURT 2004, Dulaimi, et al. 2002, Egan 1998, Fischer 1989, Froese, et al. 2000, Issa 2003, Knight 2008, Martin and Songer 2004, Mitropoulos and Tatum 2000, O'Connor 2009, Schwegler, et al. 2001, Sullivan 2009, Tang 2001, Thomas 2004, Whaley 2009). One of the most important roles of technology in the construction industry is collaboration (Sullivan 2009). The use of technology should improve the flow and exchange of information among project team members, the design capabilities, the logistics management, the construction, the commissioning and the operation of the project (Knight 2008, Tang 2001). The main focus of the use of technology for project integration is in communication, allowing multiple organizations, location and people to share and integrate documents. It is ideal for every party in the project to have access to the same information. And questions regarding schedule, budget, resources, design, etc. can be solved in real time. Additionally, technologies should help prevent the loss of information from one phase of the project to the other (Sullivan 2009).

Information Technology (IT) is making great progress lately, solving many technological issues and giving the industry more powerful tools to promote project integration. As Froese et al. (2000) say "recent trends in information technologies move us closer to the goal of integrating the computing tools used throughout architecture, engineering, construction and facilities management". IT is allowing the creation of more realistic and comprehensive models that ensure that the project is going to be build right the first time (Froese, et al. 2000, Thomas 2004).

There are several tools that claim to improve project integration; BIM is a very powerful collaboration tool that is probably the most accepted tool at this moment (AIA National and AIA California Council 2007, Batcheler and Howell 2005, Bedrick, et al. 2006, CURT 2004, Eastman, et al. 2008, Knight 2008, O'Connor 2007, O'Connor 2009, Yoders 2008). BIM is a process that uses parametric objects to generate a model. Parametric objects are those that are defined by the rules embedded in them. There are different types of information found in BIM. Component information is the visual information that resides in the model itself (geometric information, material, location). Parametric information is editable information embedded in the object; it is composed mainly of intellectual information such as part numbers or material quality. Linked information is information that is not part of the model but is somehow connected to the model; this information can be either visible or invisible. External information is produced separate from BIM, it can be linked to the model or remain autonomous; the model is connected to a library folder that contains all the usable components (Eastman, et al. 2008, Kymmell 2008). Parametric information allows a small number of objects define a large number of building elements (O'Connor 2007).

BIM is a real-time, intelligent, multidimensional, and dynamic model that has the capabilities to combine the design, fabrication information, erection instructions, and project management logistics under one database, facilitating the coordination, checking, and reviewing of the project. Therefore, BIM can change the way people communicate and work. BIM is a platform for collaboration that allows virtually modeling the entire project before construction starts. BIM is based on a single consistent project database where the different project participants can store their models; information in the database is supposed to be consistent and coordinated. The model is composed of a set of objects that contains properties and drawings are created from the information of the model. In addition, other information can be extracted from the model depending on the properties included, for instance spreadsheets, tables, schedules, descriptions, etc. In addition BIM can serve as a management tool of the facility during operation and maintenance (AIA National and AIA California Council 2007, Knight 2008, O'Connor 2007, Sullivan 2009).

BIM applications are still limited, but they have great potential in the near future (Khemlani 2009, Knight 2008). Thomas (2004) affirms that BIM will have great impact on the construction industry; however the industry was then very far from the adoption of BIM to use it to its full extent.

Zuppa et al. (2009) affirm that the main benefits for the Architect and the design team in terms of using BIM is having a tool for improving coordination, business opportunities and design productivity, while their main challenges are associated with the learning curve and the quality of BIM professionals. On the other hand the benefits of BIM for constructors are in regard to improving schedules, estimating, coordination, understanding of the project, and generation of as-builts; while the challenges are associated with new roles, legal and insurance implications and new submittal process. In addition, Sullivan (2009) implies that the main benefits of using BIM is to have an improved design, use less time to produce construction documents, have a reduction in change orders because of reduced errors and omissions and to help on scheduling and staging before the construction starts.

The AIA National and AIA California Council state that even though BIM goes hand in hand with project integration, it is a tool, not a project delivery method (AIA National and AIA California Council 2007). In addition Whaley (2009) affirms that it is possible to have an integrated project without the use of BIM; however huge advantages are lost, because BIM serves as catalyst for IPD when architects, engineers and contractors collaborate during preconstruction. That is why the AIA's IPD agreements require the use of BIM (Harness 2008, O'Connor 2009). However, Egan (1998) affirms that technology by itself will not be able to solve the efficiency and quality problems in the construction industry. It is important to have a cultural change first, and then use technology as a tool to support these changes and improvements.

According to Sullivan (2009) BIM is not enough, and IT technologies for integrated projects should be based on three main areas: collaboration software, integrated web-based applications and BIM, because as previously stated BIM is a tool, not a delivery method. It is not a tool to track communications, store process information or best practices. It is a way for organizing building information. Therefore, in spite of being a very important component of the information technologies required for an integrated project, it remains a sub-set.

Sullivan (2009) position is similar to the position of Froese et al. (2000), who state that technologies that can help to integrate the industry by supporting multi-disciplinary interaction and decision making are the business to business internet applications and industry data standards such as IFC that support BIM. They affirm that decisions should be made quickly, but should be based on many kinds and sources of information such as CAD models, cost estimating and construction schedules, milestones, etc. In addition, it is important to understand the critical relationships between project information and to highlight critical information required. They developed a research project where they explored the use of advanced interactive workspaces, which used several construction related software tools, such as 4D CAD, Primavera Project Planner for scheduling and resource management, and Timberline for cost estimating. And they concluded that an integrated system for AEC/FM should be based on a distributed system that integrates different software tools. Thus users would interact with the system using application programs such as CAD, estimating applications, etc., and each application maintains its data in addition to the information shared throughout the entire system.

Intensive Involvement and Commitment of the Owner

The intensive involvement and commitment of the owner is essential for the success of an integrated project (AIA National and AIA California Council 2007, CURT 2004, Dainty, et al. 2001, Egan 1998, Lichtig 2005, O'Connor 2009, Rahman and Kumaraswamy 2004, Tang 2001, Busby Perkins and Will and Santec Consulting 2007).

Additionally, the knowledge the owner has of the project and of the construction industry is very important (Tang 2001).

According to O'Connor (2009) "If real improvement is to be achieved, it must be through owners demanding more innovation and collaboration from their design and construction professionals. Only owners can drive the industry toward IPD". Owners are the ones who must lead the transformation of the industry because they can require the creation of collaborative teams formed by designers, constructors and facility managers; in addition they can demand the open share of information and the engagement on the use of appropriate technology (CURT 2004). Moreover, owners are the ones who select the procurement strategy and the contracting structure of the project, so they can modify the behavior of the industry (Tang 2001).

It is very important that the owner takes an active role during the design and construction, because when the owner is involved, regular feedback exists between the owner and the rest of the team. Because of this, project requirements can be clarified when necessary, minimizing gaps between expectations and final outcomes, and informed decisions can be made early in the process (CURT 2004, Tang 2001, Busby Perkins and Will and Santec Consulting 2007).

An additional important responsibility consists on being able to distinguish between short term and long term benefits, and between overall value and initial capital costs when making decisions (Tang 2001). Moreover, owners need to understand that there are some resources in terms of costs and time that need to be invested during the planning and designing phases of the project (Egan 1998).

One Team One Location

There are some authors who suggest that a more integrated environment is accomplished when the project team moves to a certain location where it can operate in an integrated fashion (Baiden, et al. 2006, Sun and Aouad 2000, Thompson and Sanders 1998, Whaley 2009). This facilitates communication by providing a more effective conversation, in addition a great amount of skills and knowledge are combined in a group. The benefits of having the team in one location are autonomy in decision making, immediate feedback, team identity, variety of work performed, and increased accountability (Thompson and Sanders 1998).

However, Sun and Aouad (2000) assert that this is always not practical and it is not possible to bring all the team members to one physical location, therefore they state that it is necessary to have a virtual workspace that supports close teamwork.

Open and Continuous Communication

It is essential to maintain open and direct lines of communication between all project participants, and communication needs to happen when needed (AIA National and AIA California Council 2007, Chan, et al. 2004, CURT 2004, Glagola and Sheedy 2002, Knight 2008, Koutsikouri, et al. 2008, Kumaraswamy, et al. 2005, Lichtig 2005, Rahman and Kumaraswamy 2004, Rooney 2006, Skal 2005, Sullivan 2009, Sun and Aouad 2000, Thompson and Sanders 1998, Busby Perkins and Will and Santec Consulting 2007).

Effective transparent communication is essential as part of the integration process for many reasons. It helps manage change and manage the team, it is the catalyst to achieve teambuilding and to create mutual trust because it helps each team member to better understand the risks of other parties, it helps break down discipline and hierarchical barriers, it facilitates the exchange of ideas, visions and to overcome difficulties, it reduces conflict, it gives the team a sense of ownership over the process, it helps the team enrich from each individual, and it allows the development of synergistic relationships. In addition, it is necessary to open the boundaries of the relationship because it relieves stress and enhances adaptability, information exchange and collaborative problem solving (Chan, et al. 2004, Glagola and Sheedy 2002, Koutsikouri, et al. 2008, Busby Perkins and Will and Santec Consulting 2007).

The communication needs to be clear, and all project members should understand the project, their responsibilities, and the project goals, it has to be adopted at all levels and by all stakeholders. Because of this, problems that occur onsite should be solved at the lowest level immediately (Chan, et al. 2004, Koutsikouri, et al. 2008). It is very important to encourage formal and informal lines of communication not only in meetings but also between meetings (Busby Perkins and Will and Santec Consulting 2007). Team members must be open and honest in their communications in the day to day operations and in their goals and objectives for the project (Glagola and Sheedy 2002).

Collaborative Process

According to several authors an integrated process should be based on collaboration (AIA National and AIA California Council 2007, Baiden, et al. 2006, CURT 2004, Knight 2008, Koutsikouri, et al. 2008, Lichtig 2005, Martin and Songer 2004, O'Connor 2009, Sullivan 2009, Thompson and Sanders 1998, Busby Perkins and Will and Santec Consulting 2007). As Lichtig (2005) described “collaboration occurs best when the participants view themselves as equal participants in the process”.

Therefore, in order to achieve collaboration it is important that the entire team early in the process explores the problems, not that someone communicates the intended solutions, and that project participants look beyond their own interests to consider other stakeholders. It requires the right people doing the right activities, who trust each other, and have a mutual expectation about project outcomes (Lichtig 2005, Martin and Songer 2004, O'Connor 2009).

It is very important that the processes and the culture of each company involved in the project to be aligned in a collaborative manner (Baiden, et al. 2006). Collaboration should be executed through information sharing early in the project (CURT 2004).

Organization and PM Leadership

For an integrated project to be successful its leaders need to believe in the process and encourage it (AIA National and AIA California Council 2007, Egan 1998, Glagola and Sheedy 2002, Knight 2008, Koutsikouri, et al. 2008, O'Connor 2009). Because there is an enormous influence of a leader in the project process and in the team motivation (Koutsikouri, et al. 2008). According to Koutsikouri et al. (2008) project management should go beyond a set of techniques to deliver a project on time, within budget and to conform to specification, it has to be a hands-on task that makes the project process smoother. Project leaders should be committed to change, should be able to communicate the cultural and operational changes that should take place at the project level (Egan 1998). In addition they should be supportive in terms of giving the team freedom and autonomy in the process and should nurture a team culture (Koutsikouri, et al. 2008, O'Connor 2009). Leadership is important to facilitate timely decisions and dispute resolution, and to clarify issues (O'Connor 2009).

Information Share and Exchange

An integrated approach demands that people from different organizations openly exchange information in order to achieve project goals (AIA National and AIA California Council 2007, Baiden, et al. 2006, CURT 2004, Fischer 1989, Froese, et al. 2000, Knight 2008, Kumaraswamy, et al. 2005, Mitropoulos and Tatum 2000, Sullivan 2009, Sun and Aouad 2000, Thompson and Sanders 1998). Information should flow quickly, effectively and freely among team members, all team members should be responsible for the information (CURT 2004).

In order to have tools that can help to integrate the information of the entire project it is necessary that, not only software tools have the capability of sharing information, but also that team members are willing to do so (Froese, et al. 2000). Current impediments to information sharing should be counteracted by a new business model and different contracts (CURT 2004).

Continuous Improvement

It is important for project integration to generate a culture of continuous improvement at the project level (Egan 1998, Koutsikouri, et al. 2008, Lichtig 2005, Rooney 2006, Tang 2001, Busby Perkins and Will and Santec Consulting 2007). All decisions should be evaluated at different stages of the project in an iterative process that helps those decisions reflect broad team knowledge, the understanding of all interactions, and the optimization of the project (Busby Perkins and Will and Santec Consulting 2007). In addition, lessons learned should not be discussed just at the end of the project to be applied on the next project; it is important to have periodic reviews to improve during the project, especially in multiyear projects, because it is important to learn from every sub-process (Lichtig 2005).

Knowledge Sharing

The industry needs to understand that its people are its greatest asset; talent should not be wasted and the great contribution of each party should be encouraged in order to achieve innovation, better performance and project integration (Egan 1998, Fischer 1989, Koutsikouri, et al. 2008, Kumaraswamy, et al. 2005, Lichtig 2005, Rooney 2006, Tang 2001, Busby Perkins and Will and Santec Consulting 2007). It is important to encourage the sharing of knowledge and ideas among the team in an environment of respect and tolerance. Participants with different disciplines should attack the same problem simultaneously benefiting from the knowledge of others (Lichtig 2005).

Eliminate Multi-Layer Subcontracting Structure

Tang (2001) affirms that the current multilayer subcontracting structure should be eliminated because it reduces the accountability of parties involved. In addition, subcontractors are the ones who actually perform the job and are the ones who have the most fragmented culture and structure.

Common Goals and Objectives

As previously stated, setting project goals upfront is very important. However, it is essential as well that the project goals take into consideration the project members' goals and the individual's goals, and that these goals are determined though consensus, and are not just the owner's goals. In this way, the project goals will reflect the team goals and individuals from different organizations will be working together in order to achieve those common project goals (Baiden, et al. 2006, Fischer 1989, Glagola and Sheedy 2002, Knight 2008, Koutsikouri, et al. 2008, Kumaraswamy, et al. 2005, Martin and Songer 2004, O'Connor 2009, Rahman and Kumaraswamy 2004, Tang 2001, Thompson and Sanders 1998, Busby Perkins and Will and Santec Consulting 2007).

Clear responsibilities and clear Accountability Structure

Although team members should have common objectives in an integrated project, it is very important to establish responsibilities and to establish a clear accountability structure (Chan, et al. 2004, CURT 2004, Knight 2008, Koutsikouri, et al. 2008, Tang 2001, Thompson and Sanders 1998, Thompson and Sanders 2008, Busby Perkins and Will and Santec Consulting 2007). Each team member should have clarity about their roles and responsibilities as part of the team very early in the process (Chan, et al. 2004, Knight 2008, Koutsikouri, et al. 2008, Busby Perkins and Will and Santec Consulting 2007). There should be collective responsibility for project success (CURT 2004).

Contracting structure

The contracting structure and contract forms play a very important role in project integration, because contracts set how the different parties are going to interact in the project and who is responsible to whom (Egan 1998, Knight 2008, Kumaraswamy, et al. 2005, Lichtig 2005, Martin and Songer 2004, Mitropoulos and Tatum 2000, O'Connor 2009, Rahman and Kumaraswamy 2004, Rooney 2006, Skal 2005, Sullivan 2009, Thompson and Sanders 1998).

Kumaraswamy et al. (2005) affirm that it is important to foster moving contracts from rigid and dispute-driven towards more flexible relational contracts, because the use of relational contracting gives rise to effective teamwork. Knight (2008) affirms that integration requires contracts that foster collaboration and communication, thereby integrating the efforts of the entire team to have a successful project. In addition, contracts should include a well-defined scope of work, the owner's project requirements, all parties' duties and responsibilities, and the terms and conditions agreed by all parties; moreover information sharing should be encouraged and should be contemplated on the contracts (AIA National and AIA California Council 2007, Harness 2008, Knight 2008, O'Connor 2009, Sun and Aouad 2000).

Lichtig (2005) proposes an integrated agreement. According to him an integrated agreement is an agreement signed by the owner, the architect and the contractor as the core group, the main difference with design-build agreements is that in design-build one entity takes all responsibility for the project. An integrated agreement clearly states the responsibilities of each party identifying the different members of the team. One objective is to align the interests of each party with the interests of the project. The team selection criteria are based on a request for proposals based on quality and value, instead of lowest price. The core group selects the other project participants and invites them to join or leave the team through a joining agreement. Major consultants and subcontractors should join the project at the schematic design phase. Executive input is required; therefore senior executive personnel from the core group are expected to join meetings at least quarterly. The agreement should express the goals of the project upfront, and should require that the core group develop a target value design plan that states that value, cost, schedule and constructability are part of the design criteria. It should include an internal strategy of conflict and dispute resolution led by the core group. It should create a system of shared risk.

In the United States there are new contract forms that try to foster project integration. The main forms are described in the next paragraphs.

In 2007 and 2008 the AIA released a new set of contract forms that include agreements for implementing IPD and for managing the use of BIM across the entire life of a project. In 2007 the AIA launched the E201-Digital Data Protocol Exhibit and C106-Digital Data Licensing Agreement that allow team members to identify how and in which file format information can be transmitted across the project. In 2008 the AIA launched E202-Building Information Modeling Protocol Exhibit, that can be attached to any agreement for design services or construction (Harness 2008).

The AIA created two different contract families in order to support IPD. The first one is the A295 family, composed of an owner-architect agreement and a guaranteed maximum price owner-contractor agreement that incorporate general conditions for IPD. Even though this contract is based on a traditional delivery model, it includes preconstruction services from the general contractor to work with the designers during the design phase. In addition the most important difference with previous contracts is that it does not set the duties of the owner, architect and contractor in separate silos, but it integrates the duties of each participant with the activities of the other two for each phase of the project. This is a transition contract (Harness 2008, O'Connor 2009).

The second one is the SPE (Single Purpose Entity) family. This contract completely differs from traditional contracts, and is based on the principle of mutual benefits and rewards for all members of the team. In this contract the owner, architect, construction manager, and other key project participants, become members of the single purpose entity, whose objective is to design and construct the project. It is a separate limited liability company from the members' organizations. The owner provides funding to the SPE using one agreement and each non-owner members provides services to the SPE using other agreement. The non-owner members get paid the costs of providing the specific service they provided to the project, and the profits are linked to achievement of project goals and shared savings provision. One very important characteristic of the SPE is that in order for one member to earn profit, all members must earn profit, thus each member is motivated to help other members to achieve their goals. This contract is based on the IPD from the AIA (Harness 2008, Knight 2008, O'Connor 2009).

Knight (2008) states that a SPE contract can have the same problems as other more conventional contracts, if the team is not adequately selected and if there is competition and conflicting interests.

Another contract form developed for a collaborative project delivery is the ConsensusDOCS 300 published in 2007 (O'Connor 2009). As part of this agreement there is a Management Group that is the decision making body of the project, composed of representatives of the owner, the architect and the contractor. In addition, there is a Collaborative Project Delivery Team that is a more hands on group that facilitates design, construction and commissioning. Subcontractors and other consultants are also part of this group and sign a joining agreement accepting the integrations principles (O'Connor 2009).

According to O'Connor (2009) a major difference between previous attempts of contracts to integrate the project and IPD, is that contract forms such as the new set of AIA's contracts and ConsensusDOCS now also describe culture.

Use a Facilitator or team leader

It is important for the integration process to have an effective facilitator who can help develop communication skills, fosters respect and trust, guides the project team in the integration process, aligns individual goals and project goals, understands that the ideas and actions of every person in the team are essential for success, eliminates the fear of conflict, gets commitment from the different stakeholders for the success of the project and the success of each stakeholder, makes each party accountable for their responsibilities, pays great attention to the excellence and quality results of each member, and has leadership skills (Glagola and Sheedy 2002, Knight 2008, Mitropoulos and Tatum 2000, Rahman and Kumaraswamy 2004, Whaley 2009, Busby Perkins and Will and Santec Consulting 2007).

There are different points of view as to whether the facilitator should be an internal facilitator or an external one. According to Busby Perkins and Will and Santec Consulting (2007) the facilitator can be either an internal or external member of the team, should keep the goals and targets present, and should update them throughout the process, should have facilitator skills, ensure the participation of all members, and ensure the flow of information. On the other hand, Glagola and Sheedy (2002) state that it is better to have an external facilitator, because it is very difficult to find somebody within the team who can conduct integration sessions without any bias and with the entire support of the team. In addition to an external facilitator, each organization should appoint an internal champion who could encourage team building and communication strategies within the organization. Professional facilitators should be used at the initial sessions and at some sessions afterwards to help the improvement of communication, group and organizational dynamics and team building. According to Knight (2008) this role can be taken by different project participants depending on the nature of the project and the skills of team members. The leader can be someone from inside the project such as the owner, architect or general contractor or an external facilitator. Finally, Kumaraswamy et al. (2005) found on their research that having a full time external facilitator is not a requirement to build an integrated team.

Project Delivery System Selection

The project delivery method selected has a very important influence in the integration of the project (Baiden, et al. 2006, Dulaimi, et al. 2004, Dulaimi, et al. 2002). According to Biden et al. (2006), the project that uses design-build as its delivery method presents the highest level of integration. However, this type of project delivery system does not provide a fully integrated project. There are clear boundaries in terms of organizations and disciplines; there are not clear benefits to all project members, and the goals are aligned with the parent organization goals instead with the project goals. On the other hand, there are construction management projects that highlight several integration characteristics, but those projects are not fully integrated either because each party maintained their organizational identifies and boundaries. Finally the most fragmented projects are the ones procured using design-bid-build. Moreover, Dulaimi et al. (2004) affirm that to encourage closer integration, selecting a Design-Build delivery method should be preferred. However, laws and regulations should be modified to facilitate Design-Build.

Adequate Resources

It is very important to have available adequate resources in terms of knowledge, technology, information, specific skills, capital and time; and to share the resources among the different organizations in the team in order to attain integration (Chan, et al. 2004, Rooney 2006, Thompson and Sanders 1998).

Support from Top Management

Top management support and commitment from the parent organizations of the team members are critical because they are the ones who formulate the strategy and the direction of business activities (Chan, et al. 2004, Egan 1998, Glagola and Sheedy 2002, Lichtig 2005, Mitropoulos and Tatum 2000, Rahman and Kumaraswamy 2004, Thompson and Sanders 1998). Top management should communicate and support the cultural and operational changes that need to take place throughout the entire organization to be part of an integrated project (Egan 1998). There is a need for top management to express its full commitment to integration, because it has a great influence in the integration culture, O'Connor (2009) states "alliancing has a higher chance of failure where there is inadequate support from top management".

Long Term Commitment

Long term commitment is very important because parties can balance the attainment of short term objectives with long-term goals; it reduces the fear for opportunistic behavior, eliminates waste in the process, and improves projects by learning from experience (Chan, et al. 2004, Dainty, et al. 2001, Mitropoulos and Tatum 2000, Rahman and Kumaraswamy 2004, Thompson and Sanders 1998). Long term relationships should be based on trust and reputation, and goal congruence (Mitropoulos and Tatum 2000).

Efficient Coordination

It is important that there is coordination among team members in order to achieve integration (Chan, et al. 2004, Knight 2008, Lichtig 2005, Mitropoulos and Tatum 2000, Rahman and Kumaraswamy 2004, Thompson and Sanders 1998). Coordination can be achieved by sharing project information and by facilitating points of contact between the different parties (Chan, et al. 2004).

Understanding of other Parties' Needs, Expectations and Discipline

In order to attain integration it is necessary that each party understands the needs, expectations and discipline of other parties in the team (Chan, et al. 2004, Dainty, et al. 2001, Egan 1998, Glagola and Sheedy 2002, Martin and Songer 2004, Rahman and Kumaraswamy 2004, Thompson and Sanders 1998). As Thomas (2004) states: "When engineers and quantity surveyors discuss aesthetics and architects study what cranes can do, we are on the right road". Designers should understand how building components are manufactured and assembled. They should use their creative and analytical skills to have a greater effect on the process as a whole (Egan 1998).

In order to create a cooperative attitude and to use win-win thinking it is necessary that each party understands the goals, objectives, mission, and needs of other parties (Chan, et al. 2004, Glagola and Sheedy 2002). In order to achieve collaboration, it is important to understand the technologies, finances and operations of other participants (Martin and Songer 2004).

Subcontractor and Supplier Involvement

It is essential to involve subcontractors and suppliers in the process as part of the project team if integration is to be attained, because they are the ones who are actually performing the work (Chan, et al. 2004, Chua, et al. 1999, CURT 2004, Dainty, et al. 2001, Egan 1998, Glagola and Sheedy 2002, Knight 2008, Mitropoulos and Tatum 2000). According to Dainty et al. (2001) "leading companies must agree to share the benefits of greater integration with their supply chain partners if integration is to be improved". The use of knowledge of the suppliers can have a significant contribution to innovation (Egan 1998).

Facility Manager Involvement

Most of the literature on project integration talks about the importance of integrating and involving as part of the team the owner, architect and general contractor. However some authors such as CURT (2004) recognizes that in order to have a real integrated team it is necessary to involve the facility manager as part of the team since early in the process.

Less Reliance on Contracts

Integrated projects should not rest on contracts, because they add costs to the owner, but they do not provide much value; therefore, the relationship between the team should be based on mutual interdependence (Egan 1998). Martin and Songer (2004) affirm that the industry needs to move from contracts to covenants that encourage common goals and a trusted based relationship, because "contracts act in opposition to collaboration, whereas covenants better reflect mutual effort and trust". They state that as in a fully cooperative effort the group and system utility will be optimized, the individual utility to each participant will by sub-optimized, therefore it is necessary to go beyond contracts to have sustainable collaboration. Contracts are used to define behaviors but not commitment. Contracts in collaborative environments are a dilemma between acting on the own interests or acting on the interest of the project and the team. Contracts are based on the fear of doing something wrong.

Eagan (1998) recognizes that this is very difficult in the construction industry, but thinks that in the future, the industry needs to move in that direction as many companies from other industries have done.

Open Book Accounting

According to Egan (1998), Rooney (2006), and Skal (2005), an open book accounting helps on building trust between the team, on reducing the reliance on bidding and contracts themselves. In addition, it keeps all team members accountable for their participation in the project. Therefore, it is essential for project integration.

Personal Attitude and Commitment

It is necessary to have a change in attitude, mindset and commitment from every person who is involved in the process at all levels, from the working-level people working at the jobsite on a daily basis to the top management (Glagola and Sheedy 2002, Knight 2008, Kumaraswamy, et al. 2005, Martin and Songer 2004, O'Connor 2009, Rahman and Kumaraswamy 2004, Skal 2005). Commitment is developed when individuals develop personal relationships with their counter parts and understand the motivations of the entire team (Glagola and Sheedy 2002).

Changes in contracts, the inclusion of new technology and other things provide theoretical foundation for an integrated team. However, the shift will not be effective if people involved in the project are not convinced and motivated towards integration (Kumaraswamy, et al. 2005).

Timely responsiveness

In the construction industry time equals money, therefore timely decisions increase production and reduces the possibility that a conflict will evolve in a claim or dispute, contributing to project integration (Glagola and Sheedy 2002, Thompson and Sanders 1998).

Members' Company Culture

Not all the companies are very suited to participate in an integrated project, because the culture of the project plays a major role. Individuals come to the project not only with their individual culture, but with their company's culture, if there is an internal culture of collaboration and teamwork with other companies, integration is easily achieved (Egan 1998, O'Connor 2009, Rahman and Kumaraswamy 2004).

Project Integration and Project Performance

It has been stated in previous sections that one of the most important motivations to change industry practices towards a more integrated approach to project delivery; it is to improve the performance of the industry. Therefore it is important to understand what is project performance or project success criteria and how these criteria are associated with project integration.

Project Performance and Project Success Criteria

According to Chan and Chan (2004) project success means different things to different people. They define criteria for project success as "the set of principles or standards by which favorable outcomes can be completed within a set specification". In the early 1990's, project success was evaluated in terms of time, cost and quality. These three criteria are identified in almost all performance or project success papers and articles (Baiden, et al. 2006, Chan and Chan 2004). Lately, several authors have identified that some psychological outcomes are also very important when assessing the success of a project; for instance the inclusion of project participant's satisfaction. Other authors have also included the absence of legal claims, safety and friendliness of environment and health issues as indicators of a successful project (Baiden, et al. 2006, Chan and Chan 2004).

In addition, there are some authors that have included different dimensions to the measurement and assessment of project success; they affirm that the success of the project should be evaluated at different times. There should be some indicators directly related to the delivery stage such as cost, time, efficiency, quality, safety, environmental impact, etc. But there are other indicators that can be evaluated on the longer term such as legal claims, long term relationships, value of the property, benefits to all stakeholders, ease of operation etc. (Chan and Chan 2004).

Functional aspects of project performance (e.g., cost, time, quality), and human aspects (e.g., participant's job satisfaction) should be taken into consideration if the overall project performance is to be judged (Chan, et al. 2001). In addition, for the industry to perceive improvements in performance, the objectives and targets should be measured in terms of owner's perception of performance, such as predictability, cost, time and quality, and in terms of the construction process such as safety and productivity (Egan 1998).

Chan and Chan (2004) developed a very comprehensive model of key performance indicators to assess the success of the project, which includes most of the criteria cited by other authors such as Baiden et al. (2006), Chan, et al. (2001), Egan (1998), Chan et al (2004), Chua et al. (1990), Yeung et al. (2007). Chan and Chan (2004) decided to divide performance indicators in two groups: one based on objective measures that use mathematical formulae to calculate their values, and other based in subjective measures that use opinions and personal judgments of project participants. The indicators of the first group are construction time, speed of construction, time variation, unit cost, percentage net variation over final cost, net present value, accident rate, and environmental impact assessment scores. The indicators of the second group are quality, functionality, end users' satisfaction, client's satisfaction, design team's satisfaction, and construction's team satisfaction.

According to Chan and Chan (2004), time is associated with the duration of the project and is related to the concept of effectiveness. Effectiveness is the degree to which time and cost targets are met. There are three measurements associated with time. Construction time is the absolute duration of the construction phase measured in days or weeks. Speed of construction is the relative time by square footage. Time variation is the increase or decrease of the scheduled time as a percentage. On the other hand, cost can be measured in terms of unit cost and percentage of net variation over final cost. The unit cost is the relative cost of the project by square footage. The percentage net variation over final cost is an indicator of cost overrun or under run as a percentage of the budget. Value and profit is the business benefit of the project from the client perspective, it is usually calculated as a total project net present value. Health and safety is a measure of the number of accidents per number of man hours worked on a specific project. Environmental Impact is a major problem associated with the construction industry. It is now recognized that environmental protection is desired by many clients. To measure it there are different assessment indexes, one that is widely accepted is the application of ISO 14000. Quality is defined as the achievement of features required to fully satisfy the needs, and it is measured as the extent of meeting specifications. Functionality is a measure of how a project fulfills its intended function. User's expectation and satisfaction is a measurement of how the project satisfies the final user expectations, this is a measure that would take place post occupancy. Participant satisfaction measures how each project member felt while working on the project overall.

Measurement of Partnering Performance

Partnering is one of the first attempts of an integrated project. Some of the different measurements that have been developed to measure partnering project performance are listed below.

Glagola and Sheedy (2002) described a study conducted by the Construction Industry Institute (CII) in the United States to determine opportunities for long-term partnering in terms of improving performance. They included six categories of benchmarks, including cost, schedule, safety, quality, claims and other. They used traditional metrics such as total project cost, schedule changes, lost workdays, rework, number of claims, using discrete metrics, and job satisfaction using a subjective rating. The CII compared the results of projects using partnering efforts to the industry average, finding that partnering projects outperformed. However, they found that in 1996 there was not a major difference between long-term partnering and single-project.

On the other hand Yeung et al. (2007) developed four major categories that encompass the different criteria to assess performance of a partnering project. Category one is based on result-oriented objective measures, and includes time performance, cost performance, profit and financial objectives, scope of rework, safety performance, environmental performance, productivity, and pollution occurrence. Category two is based on result-oriented subjective measures, which includes quality performance, professional image establishment, client's satisfaction, customer's satisfaction, job satisfaction, innovation and improvement. Category three is based on relationship-oriented objective measures, which includes litigation occurrence and magnitude, claim occurrence and magnitude, and introduction of facilitated workshop. And category four is based on relationship-oriented subjective measures, which includes trust and respect, effective communications, harmonious working relationship, top management commitment, employee's attitude, reduction of paperwork.

Project Success Criteria and the Attributes for Successful Integration

Several researchers and practitioners have developed models for project success or project performance and have identified the project success factors. These factors are different aspects that somehow influence the success of the construction project. Many of the criteria that have been identified as important in order to achieve a successful project are the same attributes required to have an integrated project. The factors that Chan et al. (2004) identified as necessary for a successful project and also identified as attributes required for successful integration are: the communication system, continuous improvement, an intensified planning effort, having a strong organization structure, the selection of the project delivery system, team selection criteria, technology, and the contribution, the experience and the knowledge of the owner.

Chua et al. (1999) developed a similar model and divided the attributes according to categories. The categories and the attributes that they identified as necessary for a successful project that are identified as attributes required for successful integration are presented in Table 4.

Table 4- Categories and Attributes Identified by Chua et al. (1999) as Important for Project Success

Categories	**Attributes**
Contractual agreements	Realistic obligations and clear objectives, risk identification and allocation, adequacy of plans and specifications, the process of dispute resolution, and the motivation and incentives for all the team
Project participants	Importance of the participation, leadership and Commitment of the project manager, the involvement and knowledge and capabilities of the client and client personnel, and the competency and involvement of designers and consultants, general contractor, subcontractors and suppliers
Process	Formal and informal communication within each project phase and among phases, in addition to having common goals, motivation, and good relationships

Associations between Project Performance or Project Success Criteria and Attributes for Successful Integration

Many authors affirm that project performance can be significantly improved if the industry evolves towards a more integrated approach to project delivery (AIA National and AIA California Council 2007, CURT 2004, Egan 1998, Mitropoulos and Tatum 2000, O'Connor 2009, Sun and Aouad 2000, Tang 2001, Whaley 2009). An integrated project will enhance performance because the efficiency of construction projects is constrained by the fragmented process by which they are planned, designed, constructed and operated (Egan 1998).

Mitropoulos and Tatum (2000) state that there is a strong relation between the costumer's satisfaction with building performance and project integration. They affirm that the potential operational benefits of project integration are improved cost and schedule effectiveness, cash flow, safety and prevention of claims; and the potential strategic benefits are facility quality, speed of delivery, and cost effectiveness. Whaley (2009) affirms that integration has the potential to bring great improvements in terms of productivity, quality, sustainability, and financial rewards for the entire AEC industry. Tang (2001) states that if integration is attained, the construction industry performance can be improved in terms of efficiency, quality, productivity, site safety, environmental sustainability, and customer satisfaction. Kumaraswamy et al. (2005) state that integrated working reduces wastes and enhances value.

In addition to affirming that project integration can improve performance, many authors have stated different associations between the specific attributes that have been identified as required for a successful integration and different performance criteria. On the following paragraphs some of these associations will be presented.

Collaboration, coordination and cooperation are important to improve performance. According to CURT (2004), to optimize the construction process it is important to create an integrated project structure based on collaboration among project team members. The establishment of high levels of cooperation and coordination is very important to achieve performance goals, especially in terms of reduced litigation and increased efficiency (Chan, et al. 2001, Thompson and Sanders 1998). According to

Dulaimi et al. (2004) when there is cooperation among designers, contractors, subcontractors, suppliers early in the design process, the final design includes all the knowledge in terms of constructability, prefabrication and standardization (Dulaimi, et al. 2004).

Early participation of project participants also plays an important role in improving project performance, it leads to better cost control, cost reduction, labor reduction because there is a direct connection between the design and an accurate estimate, and there is more emphasis on the constructability of the design. Moreover, the design will account for safety and environmental issues; therefore, construction accidents and environmental impacts will be reduced during construction (AIA National and AIA California Council 2007, Tang 2001). In addition, to have significant improvements in performance it is necessary to take into consideration the integration of subcontractors and suppliers (Dainty, et al. 2001).

Another important aspect to enhance performance consists of extensive planning and early decision making because it helps allocating resources better, cost is better predicted and the design is of higher quality (CURT 2004). In addition, it reduces construction time (AIA National and AIA California Council 2007, Chan, et al. 2001), and helps eliminate wastes and inefficiencies (Tang 2001).

Communication has been identified by Sun and Aouad (2000) as one of the major enablers for performance improvement. An open and continuous communication will lead to better, faster and cost effective projects (Chan, et al. 2001, CURT 2004). In addition the establishment of goals at the beginning of the project will align the project team on established metrics, which is expected to improve the overall operational performance (AIA National and AIA California Council 2007).

The owner plays a very important role in project performance. According to Tang (2001) and Chua et al. (1999) a knowledgeable, involved, committed owner can help clarify the project requirements throughout the project, improving the quality of the project and enhancing budget performance. When owners are involved and require full collaboration of their teams, projects are finished faster, on budget and in an effective and efficient way (CURT 2004). Chan et al. (2004) affirm that the client and its representative are a very important factor on construction time performance.

Effective teamwork and team building is associated with project performance as well. The quality of relationships that are developed between project members, the passion for the project and enthusiasm directly affects project outcomes. When team members enjoy their work, they are willing to exert more effort to complete their responsibilities and to achieve project objectives, therefore project performance will be improved (Chan, et al. 2001, Koutsikouri, et al. 2008). Teamwork and team building are key factors that lead to productivity and bring financial and nonfinancial benefits to construction projects; Chan et al. (2001) affirm that there is a strong association between overall project performance and project participants' job satisfaction and between overall project performance and inter-organizational teamwork. Similarly, the need for integrated teams has been identified by many construction industries in the world (e.g., Australia, Hong King, Singapore, UK, USA, etc.) as necessary to achieve performance (Kumaraswamy, et al. 2005).

The level of trust among team members indirectly affects performance, because trust influences all aspects of the project management process which subsequently affect the cost of the project. There is strong evidence that the perception of the risk completely depends on the level of trust. Therefore, the premiums charged due to contract clauses depend on the level of trust between the parties. In addition, fair risk management and allocation improves the overall performance and final cost of the project (Zaghloul and Hartman 2003).

Team selection criteria and the project delivery method are also important in terms of performance. O'Connor (2009) affirms that using selection criteria that not only involve price would reduce the gap between the expected and actual performance. Chan et al. (2001) affirm that the project delivery system and the procurement process will have an impact on project satisfaction because participants can develop a positive view to the project delivery system. Egan (1998) states that there are clear quality problems when designers and constructors are selected in terms of the lowest cost and no in the value they bring to the project.

Contracts and the contracting structure play an important role in project performance. According to Lichtig (2005), the integrated agreement for lean project delivery promises performance improvements from the owner perspective in terms of reduced cost and time, and improved quality and safety; and from the design and construction team in terms of increased profit and profit velocity, improved safety and employee satisfaction. On the other hand, Thompson and Sanders (1998) state that when a separate entity is formed, results achieved include a 15% reduction in equipment and construction cost, 33% reduction in engineering rates, 100% acceptance of risk by the owner in exchange for low fees.

There are other aspects that are also important to enhance project performance. Leadership from the project manager and the statement of realistic obligations and clear objectives are essential for project successful outcomes, and for achieving budget, time and quality project objectives (Chua, et al. 1999, Koutsikouri, et al. 2008). In addition, mutual objectives and cooperative decision making among different firms who work for one objective improves their joint performance (Chan, et al. 2004).

The use of appropriate technology is believed to be a major triggering factor for enhancing project performance and the overall performance of the industry (AIA National and AIA California Council 2007, CURT 2004, Dulaimi, et al. 2004, O'Connor 2007, Schwegler, et al. 2001, Sullivan 2009, Thomas 2004). Technology has been shown to save money and time, and to improve knowledge management, additionally, the gains in terms of efficiency and productivity for the use of truly integrated information technology (IT) platforms is remarkable. (O'Connor 2009, Sullivan 2009). The use of technology and especially BIM leads to efficiencies in material procurement, because they help link schedule, phasing, and detailed construction sequencing during design (AIA National and AIA California Council 2007). In addition, tools such as BIM and building models help optimize the building systems and use of materials, reduce errors in construction documents, and reduce conflicts between systems. These can be done before materials have been procured or systems have been installed, thereby reducing the initial cost of the facility and the operation and maintenance cost and improving quality of the project. In addition, when these software applications are used early in the process, they help optimize material selection, energy consumption, site impact, and decision making in regard to all sustainability related issues (AIA National and AIA California Council 2007, CURT 2004). Teams are able to operate more effectively when they use BIM, because they can link the systems of different organizations, can easily exchange data and can create virtual models that help the team understand the project (Thomas 2004). IT enhances collaboration and cooperation, thereby enhancing competitiveness and professionalism (Dulaimi, et al. 2004). In addition, the use of virtual models that support construction sequences and means and methods can lead to a better schedule analysis and a faster construction (CURT 2004).

Egan (1998) affirms that significant improvements in terms of performance in other industries are associated with the creation of long-term relationships throughout the supply chain. Therefore, to increase efficiency and quality it is fundamental to change the culture of dealing with the project as a series of separated activities developed by designers, constructors and suppliers, who are not interested in the long term success of their product. A team that stays together will have a learning capability and will make improvements from one project to the other and will improve efficiency and quality. Benefits encountered in multi-project relationships include 40% reduction in man-hours needed per project completion, 17% reduction of staff man-hours/craft man hour ratio, 10% reduction in overall project cost, 100% success in meeting budget and schedule, 50% reduction on engineer rework, 50% reduction in sales expenses (Thompson and Sanders 1998). In addition, Dainty et al. (2001) state that the development of long term relationships between contractors, subcontractors and suppliers provide substantial improvement is terms of quality, work environment, cost reduction, productivity, margins, cash flow, image, planning for future workloads.

Barriers for Project Integration

Several authors have identified the main barriers for project integration and the main challenges that need to be overcome for integration to become a reality. The following paragraphs present some of those barriers.

According to Baiden et al (2006) the most important challenges that face project integration are:

- For many owners and construction practitioners, the drivers for project success are still cost, time and quality, oversimplifying the measurement of performance. To overcome this challenge, traditional drivers should be replaced with other performance measurements that include behavioral and cultural improvements.
- The project culture is based on short term relationships and there is a temporary nature of project teams. In addition, there is a changing composition of project teams over the project life.
- Team members see themselves as members of their organization or their discipline before members of the team. In addition some team members and even the owner do not recognize the important role that every member plays and do not treat them as equal stakeholders.
- There is not a standard measurement to determine integration and how well the team is working together. Therefore it is not possible to realize the changes over time.

Mitroupolos and Tatum (2000) identified four types of barriers to project integration.

- Contractual: when there are separated incentives and incongruent goals are promoted.
- Organizational: a reward system linked to individual performance creates incongruent goals, hierarchical decision making process delays the process, and antagonistic attitudes prevent cooperation.
- Behavioral: there is a lack of communication, problem solving and conflict resolution skills.
- Technological: there are limited standards for communication between different systems, and there is a liability concern.

Glagola and Sheedy (2002) state that change towards integration is very difficult to attain because integration is not in accordance with the norms of the community of practice. They identified four categories of barriers to partnering:

- Interpersonal: including past adversarial relationships, past adversarial experiences, ego or personality indifference, and fear of the unknown.
- Knowledge and skills: including experience with partnering, lack of understanding the principles, lack of common goals or fear of the relationship getting too close, and fear of micromanagement.
- Project structure: including lack of long-term commitment, specific contract language, bidding mentality, and too small contract size.
- Partnering process itself: including top level management commitment, working level commitment, expenses, and having the right facilitator.

Dainty et al. (2001) explain that it is very difficult to convince different members of the supply chain to be part of an integrated project because of past experiences of adversarial relationships. They obtained the following barriers to subcontractor and supplier integration:

- Financial and cost related issues: competitive bidding encourages the selection of the lower price bidder, which most of the times will not work on the best interest of the process and will try to recover its money or withholding payments that causes cash flow difficulties and also causes lack of trust and conflict in the relationship between project participants.
- Programming related issues: the time allocated to one project sometimes is unrealistic.
- Quality of information received from the general contractor and related issues.
- Attitude issues: many subcontractors and suppliers say that the managers of their payments act very aggressively and exclude them from the decisions.

CHAPTER 5

CONCEPTUAL FRAMEWORK

As presented in the literature review chapter, there are several approaches to project integration that span from structural integration of design and construction functions, to integration of information, to a change in mindsets and culture among the industry and among the individuals that compose the industry. However, to have truly integrated projects it is important to take into consideration all the dimensions of integration.

Framework Description

Success Factors for Project Integration

In order to determine the conceptual success attributes required for achieving project integration, a comprehensive literature review was developed. Attributes that compose current models of integration and current approaches to integration, and attributes identified by different authors as important for project integration were extracted.

Table 5 presents a list of the 41 identified attributes as required for successful integration in column 1. In addition, column 2 includes the authors that cited each attribute as important for successful project integration. All the attributes found in the literature review are used as conceptual integration attributes (IA) for the framework, they are found on the left side of Figure 2, Figure 3, Figure 4, and Figure 5.

Potential Association between Project Integration Success Attributes and Performance Factors or Project Success Criteria

In order to determine any potential association between project integration and project performance, it is important to understand the association of each of the integration attributes and the different project performance or project success criteria. Therefore, the conceptual associations were extracted from the literature review. Column 3 in Table 5 presents a list of the project performance or project success criterion cited in the literature as likely to experiment improvements because of integration or any of the integration attributes identified previously; the author that cited the relationship is included in the table in column 4.

The performance or project success criteria that will be used in this research are based on the model developed by Chan and Chan (2004), because it is a very comprehensive model that includes most of the factors and indicators commonly accepted by the industry. This model is based on objective measures calculated using mathematical formulae, and subjective measures that use the opinion and personal judgment of project team members. The description of the measurements is included as part of the literature review section of this proposal. The indicators used in this model are listed next:

Objective measures (mathematical formulae)

- Time Performance
  - Construction time
  - Speed of construction
  - Time variation
- Cost Performance

- Unit cost
- Percentage net variation over final cost
- Value (net present value)

- Safety and Health
  - Accident rate
- Environmental Impact

Subjective measures (opinion and personal judgment)

- Quality
- Functionality
- End user satisfaction
- Owner satisfaction
- Design team satisfaction
- Construction team satisfaction

In addition to the criteria defined by Chan and Chan (2004), the author decided to include claims and litigation as an additional Project Performance or success Criterion (PPC). Although it is a criterion not included by Chan and Chan (2004) in their model, it is cited by different authors such as Baiden et al. (2006), Chan et al. (2001), Glagola and Sheedy (2002), Thomas and Sandres (1998), Rahman and Kumaraswamy (2004), and Yeung et al. (2007), as an important criterion for project success. As well as productivity that is cited by several authors such as O'Connor (2007), O'Connor (2009), Chan et al. (2001), Thomson and Sanders (1998), Egan (1998), Sullivan (2009), Rahman and Kumaraswamy (2004), and Dainty et al. (2001), as a construction performance indicator. Claims and Litigation, and Productivity could be regarded as objective measures.

The right side of Figure 2, Figure 3, Figure 4, and Figure 5 have the list of PPC that will be used in this project; the conceptual associations between the IA and the PPC are represented in the figure with arrows.

Table 5- Attributes that influence integration and their potential association with project performance

Attributes	Authors	Performance	Authors
Appropriate risk management and shared risk	Zaghloul and Hartman (2003)	Overall performance	Zaghloul and Hartman (2003)
	Tang (2009)		Chua et al. (1999)
	O'Connor (2009)	Cost	Zaghloul and Hartman (2003)
	Skal (2005)		CURT (2004)
	Chan et al. (2004)	Time	CURT (2004)
	CURT (20040	Quality	Tang (2001)
	Kumaraswamy et al. (2005)		
	Lichtig (2005)		
	Thomson and Sanders (1998)		
	Rahman and Kumaraswamy (2004)		
	Sullivan (2009)		
	Dulaimi et al. (2002)		
	Matthews and Howell (2005)		
	Bedrick et al. (2006)		
	Rooney (2006)		
Internal conflict and dispute resolution	AIA National and AIA California Council (2007)	Overall performance	Chua et al. (1999)
	Chan et al (2004)	Value	Tang (2001)
	Glagola and Sheedy (2002)		
	Kumaraswamy et al. (2005)		
	Lichtig (2005)		
	Mitroupolos and Tatum (2000)		
	Tang (2001)		
	Rahman and Kumaraswamy (2004)		
	Rooney (2006)		

Table 5- Continued

Attributes	Authors	Performance	Authors
Project performance oriented culture	Tang (2001)	Efficiency	Egan (1998)
	Busby Perkins and Will and Santec Consulting (2007)	Quality	Egan (1998)
	Egan (1998)		
	Knight (2008)		
	Kumaraswamy et al. (2005)		
	Lichtig (2005)		
	Thomson and Sanders (1998)		
	Rooney (2006)		
Mutual respect and trust	AIA National and AIA California Council (2007)	Overall performance	Chan et al. (2001)
	Zaghloul and Hartman (2003		
	Tang (2001)		
	Baiden et al. (2006)		
	Koutsikouri et al. (2008)		
	Chan et al. (2004)		
	Busby Perkins and Will and Santec Consulting (2007)		
	Dainty et al. (2001)		
	Egan (1998)		
	Glagola and Sheedy (2002)		
	Knight (2008)		
	Kumaraswamy et al. (2005)		
	Lichtig (2005)		
	Martin and Songer (2004)		
	Whaley (2009)		
	O'Connor (2009)		
	Thomson and Sanders (1998)		
	Rahman and Kumaraswamy (2004)		
	Skal (2005)		

Table 5- Continued

Attributes	Authors	Performance	Authors
Clear benefits for all members involved	AIA National and AIA California Council (2007)	Overall performance	Chua et al. (1999)
	Baiden et al (2006)		
	Dainty et al. (2001)		
	Dulami et al. (2002)		
	Egan (1998)		
	Lichtig (2005)		
Training and education	Tang (2001)	Productivity	O'Connor (2007)
	O'Connor (2007)	Safety	Dulami et al. (2004)
	Dainty et al. (2001)		Tang (2001)
	Egan (1998)	Quality	Egan (1998)
	Mitroupolos and Tatum (2000)		Tang (2001)
	Kumaraswamy et al. (2005)	Cost	Egan (1998)
	Glagola and Sheedy (2002)		
Innovation and innovative thinking	Sun and Aouad (2000)	Productivity	O'Connor (2007)
	AIA National and AIA California Council (2007)		
	O'Connor (2007)		
	Skal (2005)		
	Chan et al. (2004)		
	Koutsikouri et al. (2008)		
	Busby Perkins and Will and Santec Consulting (2007)		
	Rooney (2006)		
Early involvement of project participants	AIA National and AIA California Council (2007)	Safety	Tang (2001)
	Tang (2001)	Sustainability	Tang (2001)
	CURT (2004)		AIA National and AIA California Council (2007)
	Busby Perkins and Will and Santec Consulting (2007)		
	Dainty et al. (2001)		
	Dulami et al. (2002)		
	Egan (1998)		
	Bedrick et al. (2006)		
	Koutsikouri et al. (2008)		
	Kumaraswamy et al. (2005)		
	Lichtig (2005)		
	Mitroupolos and Tatum (2000)		

Table 5- Continued

Attributes	Authors	Performance	Authors
Team building and teamwork	Tang (2001)	Efficiency	Sun and Aouad (2000)
	Sun and Aouad (2000)		O'Connor (2009)
	Whaley (2009)	Overall performance	Sun and Aouad (2000)
	Baiden et al. (2006)		Koutsikouri et al. (2008)
	Koutsikouri et al. (2008)		Chan et al. (2001)
	Chan et al. (2001)		Chan et al. (2004)
	Busby Perkins and Will and Santec Consulting (2007)		Chua et al. (1999)
	Dulami et al. (2002)		Kumaraswamy et al. (2005)
	Glagola and Sheedy (2002)	Productivity	Chan et al. (2001)
	Kumaraswamy et al. (2005)	Time	Chan et al. (2001)
	Lichtig (2005)	Value	Kumaraswamy et al. (2005)
	Mitroupolos and Tatum (2000)	Sustainability	Tang (2001)
	Thomson and Sanders (1998)		
	O'Connor (2009)		
	Rahman and Kumaraswamy (2004)		
	Rooney (2006)		
Team selection criteria and procedure	O'Connor (2009)	Team satisfaction	Chan et al. (2001)
	Skal (2005)	Overall performance	Chan et al. (2004)
	Koutsikouri et al. (2008)	Quality	Egan (1998)
	Busby Perkins and Will and Santec Consulting (2007)	Value	Tang (2001)
	Dainty et al. (2001)		
	Egan (1998)		
	Glagola and Sheedy (2002)		
	Knight (2008)		
	Lichtig (2005)		
	Rahman and Kumaraswamy (2004)		

Table 5- Continued

Attributes	Authors	Performance	Authors
Collaborative decision making	AIA National and AIA California Council (2007)	Cost	AIA National and AIA California Council (2007)
	Whaley (2009)		Tang (2001)
	Biden et al. 2006	Overall performance	Chan et al (2004)
	Busby Perkins and Will and Santec Consulting (2007)		
	Kumaraswamy et al. (2005)		
	Mitroupolos and Tatum (2000)		
	Thomson and Sanders (1998)		
	O'Connor (2009)		
	Rooney (2006)		
	Skal (2005)		
Intensified planning	AIA National and AIA California Council (2007)	Efficiency	AIA National and AIA California Council (2007)
	Tang (2001)	Quality	AIA National and AIA California Council (2007)
	Koutsikouri et al. (2008)		CURT (2004)
	Busby Perkins and Will and Santec Consulting (2007)		Tang (2001)
	CURT (2004)	Time	Chan et al. (2001)
	Egan (1998)		CURT (2004)
	Glagola and Sheedy (2002)	Overall performance	Chan et al. (2004)
	Lichtig (2005)	Sustainability	CURT (2004)
Early goal and objectives definition	AIA National and AIA California Council (2007)	Cost	Chua et al. (1999)
	Koutsikouri et al. (2008)	Time	Chua et al. (1999)
	Busby Perkins and Will and Santec Consulting (2007)	Quality	Chua et al. (1999)
	Glagola and Sheedy (2002)		
	Lichtig (2005)		
	Thomson and Sanders (1998)		
	Rooney (2006)		

Table 5- Continued

Attributes	Authors	Performance	Authors
Reward structure linked to the success of the project	AIA National and AIA California Council (2007)	Time	CURT (2004)
	Tang (2009)	Cost	CURT (2004)
	Skal (2005)		
	CURT (2004)		
	Busby Perkins and Will and Santec Consulting (2007)		
	Egan (1998)		
	Lichtig (2005)		
	Mitroupolos and Tatum (2000)		
	Thomson and Sanders (1998)		
	Rahman and Kumaraswamy (2004)		
	Rooney (2006)		
Appropriate use of technology	AIA National and AIA California Council (2007)	Efficiency	Tang (2001)
	Tang (2001)		O'Connor (2007)
	O'Connor (2009)		Thomas (2004)
	Schwegler et al. (2001)	Productivity	O'Connor (2007)
	Fisher (1989)		Tang (2001)
	Thomas (2004)	Overall performance	Schwegler et al. (2001)
	CURT (2004)		Chan et al. (2004)
	Dulami et al. (2002)	Time	CURT (2004)
	Froese et al. (2000)		Sullivan (2009)
	Knight (2008)	Cost	CURT (2004)
	Martin and Songer (2004)		Sullivan (2009)
	Mitroupolos and Tatum (2000)	Value	CURT (2004)
	Whaley (2009)	Sustainability	CURT (2004)
	Sullivan (2009)		
Intensive involvement and commitment of the owner	AIA National and AIA California Council (2007)	Overall performance	Chan et al. (2004)
	Tang (2001)	Cost	Chua et al. (1999)
	CURT (2004)		CURT (2004)
	Busby Perkins and Will and Santec Consulting (2007)	Time	CURT (2004)
	Dainty et al. (2001)	Efficiency	CURT (2004)
	Egan (1998)	Effectiveness	CURT (2004)
	Lichtig (2005)	Quality	Tang (2001)
	O'Connor (2009)		
	Rahman and Kumaraswamy (2004)		

Table 5- Continued

Attributes	Authors	Performance	Authors
One office location for the team	Sun and Aouad (2000)		
Open and continuous communication	Sun and Aouad (2000)	Sustainability	AIA National and AIA California Council (2007)
	AIA National and AIA California Council (2007)	Time	Chan et al. (2001)
	Skal (2005)		CURT (2004)
	Koutsikouri et al. (2008)	Overall performance	Chan et al. (2004)
	Chan et al. (2004)		Chua et al. (1999)
	CURT (2004)	Cost	CURT (2004)
	Busby Perkins and Will and Santec Consulting (2007)		
	Glagola and Sheedy (2002)		
	Knight (2008)		
	Kumaraswamy et al. (2005)		
	Lichtig (2005)		
	Thomson and Sanders (1998)		
	Sullivan (2009)		
	Rahman and Kumaraswamy (2004)		
	Rooney (2006)		
Collaborative process	AIA National and AIA California Council (2007)	Cost	Zaghloul and Hartman (2003
	Baiden et al. (2006)		Thomson and Sanders (1998)
	Koutsikouri et al. (2008)	Efficiency	Thomson and Sanders (1998)
	CURT (2004)	Reduce Litigation	Thomson and Sanders (1998)
	Busby Perkins and Will and Santec Consulting (2007)		
	Knight (2008)		
	Lichtig (2005)		
	Martin and Songer (2004)		
	Thomson and Sanders (1998)		
	Sullivan (2009)		
	O'Connor (2009)		
Organization and PM leadership	AIA National and AIA California Council (2007)	Overall performance	Chan et al. (2004)
	Koutsikouri et al. (2008)		Chua et al. (1999)
	Egan (1998)	Cost	Chua et al. (1999)
	Glagola and Sheedy (2002)	Quality	Chua et al. (1999)
	Knight (2008)	Time	Chua et al. (1999)
	O'Connor (2009)		

Table 5- Continued

Attributes	Authors	Performance	Authors
Information share and exchange	AIA National and AIA California Council (2007)	Time	CURT (2004)
	Sun and Aouad (2000)	Cost	CURT (2004)
	Baiden et al. (2006)	Efficiency	CURT (2004)
	Fisher (1989)	Effectiveness	CURT (2004)
	CURT (2004)	Quality	Tang (2001)
	Froese et al. (2000)		
	Knight (2008)		
	Kumaraswamy et al. (2005)		
	Mitroupolos and Tatum (2000)		
	Thomson and Sanders (1998)		
	Sullivan (2009)		
Continuous improvement	Tang (2001)	Overall performance	Tang (2001)
	Koutsikouri et al (2008)		Chan et al. (2004)
	Busby Perkins and Will and Santec Consulting (2007)		
	Egan (1998)		
	Lichtig (2005)		
	Thomson and Sanders (1998)		
Sharing knowledge	Tang (2001)	Quality	Tang (2001)
	Koutsikouri et al (2008)		
	Fisher (1989)		
	Busby Perkins and Will and Santec Consulting (2007)		
	Kumaraswamy et al. (2005)		
	Egan (1998)		
	Lichtig (2005)		
	Rooney (2006)		
Eliminate multi-layer subcontracting structure	Tang (2001)	Quality	Tang (2001)

Table 5- Continued

Attributes	Authors	Performance	Authors
Common goals and objectives	Tang (2001)	Overall Performance	Chan et al. (2001)
	Baiden et a.l (2006)		Chua et al. (1999)
	Koutsikouri et al (2008)		
	Fisher (1989)		
	Busby Perkins and Will and Santec Consulting (2007)		
	Glagola and Sheedy (2002)		
	Knight (2008)		
	Kumaraswamy et al. (2005)		
	Martin and Songer (2004)		
	Thomson and Sanders (1998)		
	O'Connor (2009)		
	Rahman and Kumaraswamy (2004)		
Clear accountability structure	Tang (2001)	Overall performance	Chua et al. (1999)
	Koutsikouri et al. (2008)	Cost	Chua et al. (1999)
	Chan et al (2004)	Time	Chua et al. (1999)
	CURT (2004)	Quality	Chua et al. (1999)
	Busby Perkins and Will and Santec Consulting (2007)		Tang (2001)
	Knight (2008)		
	Thomson and Sanders (1998)		
Contracting structure	Sullivan (2009)	Cost	Thomson and Sanders (1998)
	Skal (2005)	Overall performance	Skal (2005)
	Knight (2008)	Value	Tang (2001)
	Egan (1998)		
	Kumaraswamy et al. (2005)		
	Lichtig (2005)		
	Martin and Songer (2004)		
	Mitroupolos and Tatum (2000)		
	Thomson and Sanders (1998)		
	O'Connor (2009)		
	Rahman and Kumaraswamy (2004)		
	Rooney (2006)		
	AIA National and AIA California Council (2007)		

Table 5- Continued

Attributes	Authors	Performance	Authors
Use a facilitator or team leader	Whaley (2009)		
	Busby Perkins and Will and Santec Consulting (2007)		
	Glagola and Sheedy (2002)		
	Knight (2008)		
	Mitroupolos and Tatum (2000)		
	Rahman and Kumaraswamy (2004)		
Project delivery system selection	Biden et al. (2006)	Team satisfaction	Chan et al. (2001)
	Dulami et al. (2002)	Overall performance	Chan et al. (2004)
	Dulami et al. (2004)		
Adequate resources	Chan et al. (2004)		
	Thomson and Sanders (1998)		
	Rooney (2006)		
Top management support from respective organizations	Chan et al. (2004)	Overall project performance	Chua et al. (1999)
	Egan (1998)		
	Glagola and Sheedy (2002)		
	Lichtig (2005)		
	Mitroupolos and Tatum (2000)		
	O'Connor (2009)		
	Rooney (2006)		
	Skal (2005)		
Long term commitment or possibility of future work	Chan et al. (2004)	Quality	Dainty et al. (2001)
	Dainty et al. (2001)		Egan (1998)
	Egan (1998)		Thomson and Sanders (1998)
	Mitroupolos and Tatum (2000)	Cost	Dainty et al. (2001)
	Thomson and Sanders (1998)		Thomson and Sanders (1998)
	Rahman and Kumaraswamy (2004)	Productivity	Dainty et al. (2001)
			Thomson and Sanders (1998)
		Value	Dainty et al. (2001)
		Image	Dainty et al. (2001)
		Team satisfaction	Dainty et al. (2001)
		Overall performance	Egan (1998)
		Efficiency	Egan (1998)
		Time	Thomson and Sanders (1998)

Table 5- Continued

Attributes	Authors	Performance	Authors
Efficient coordination	Chan et al (2004)		
	Knight (2008)		
	Lichtig (2005)		
	Mitroupolos and Tatum (2000)		
	Rahman and Kumaraswamy (2004)		
Understand other parties' needs, expectations and discipline	Chan et al. (2004)		
	Dainty et al. (2001)		
	Egan (1998)		
	Glagola and Sheedy (2002)		
	Martin and Songer (2004)		
	Mitroupolos and Tatum (2000)		
	Thomson and Sanders (1998)		
	Rahman and Kumaraswamy (2004)		
Subcontractor and supplier involvement	Chan et al. (2004)	Overall performance	Chua et al. (1999)
	CURT (2004)	Quality	Dainty et al. (2001)
	Dainty et al. (2001)	Cost	Dainty et al. (2001)
	Egan (1998)	Productivity	Dainty et al. (2001)
	Glagola and Sheedy (2002)	Value	Dainty et al. (2001)
	Knight (2008)	Image	Dainty et al. (2001)
	Mitroupolos and Tatum (2000)	Team satisfaction	Dainty et al. (2001)
Facility manager involvement	CURT (2004)		
Less reliance on contracts	Egan (1998)		
	Martin and Songer (2004)		
Open book accounting	Egan (1998)		
	Rooney (2006)		
	Skal (2005)		
Personal attitudes and commitment	Glagola and Sheedy (2002)		

Table 5- Continued

Attributes	Authors	Performance	Authors
Timely responsiveness	Glagola and Sheedy (2002)	Claims reduction	Glagola and Sheedy (2002)
	Thomson and Sanders (1998)		
Member's company culture	Rahman and Kumaraswamy (2004)		
	Egan (1998)		
	O'Connor (2009)		

Graphical Representation of the Conceptual Integration-Performance Framework

Figure 2, Figure 3, Figure 4, and Figure 5 graphically depict the 41 integration attributes (IA) and their potential association to any of the 13 project performance criteria (PPC) described above. The representation is divided in 4 figures for easiness to read; however, the division in these 4 figures does not have any meaning and is not associated to any categorization. On the left hand side of each figure is a list of IA, on the right hand side of each figure is a list of the 12 PPC that compose the project performance model. Arrows represent possible conceptual associations.

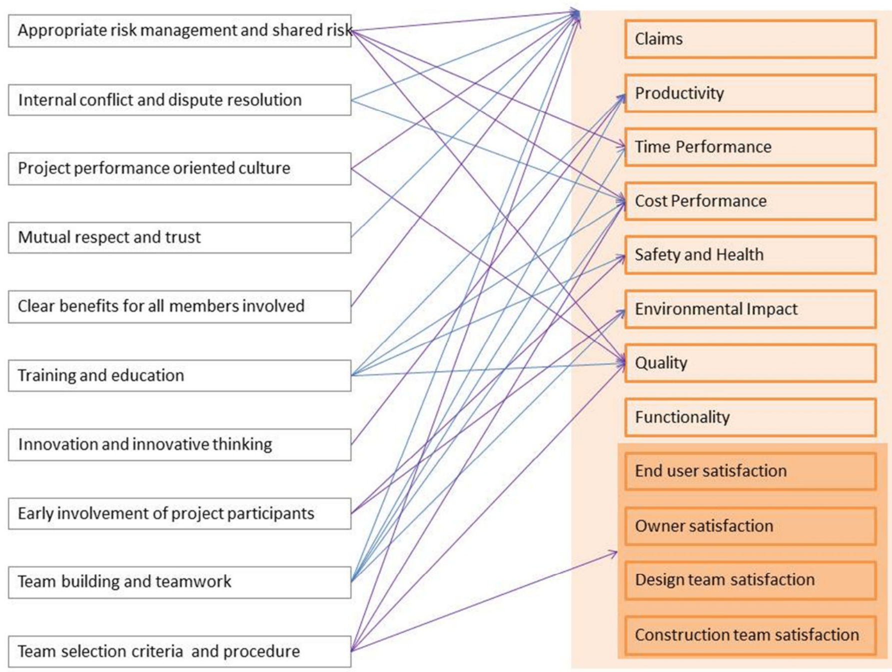

Figure 2- Integration-Performance Conceptual Framework Part 1

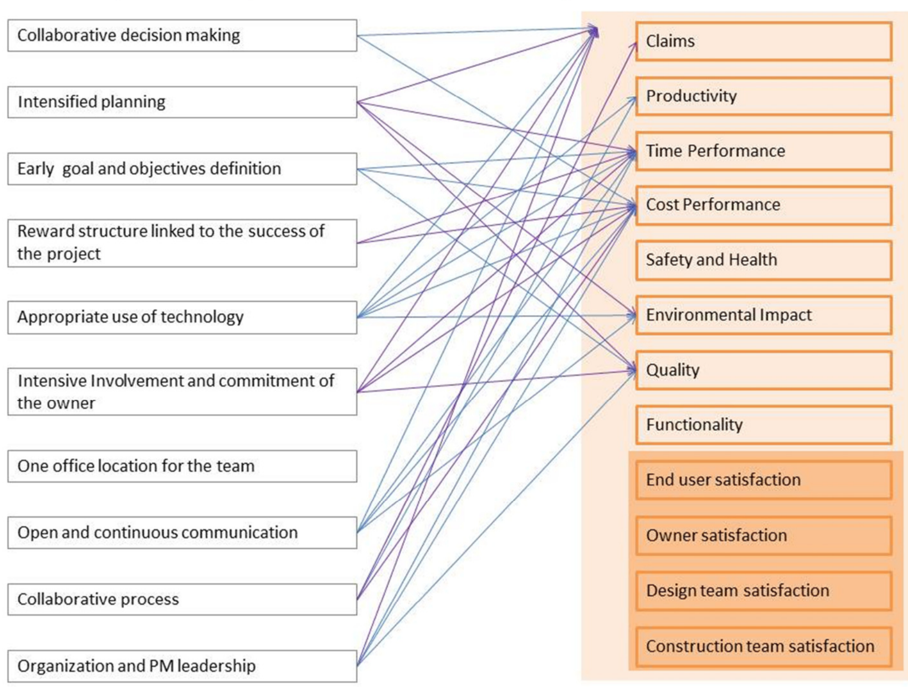

Figure 3- Integration-Performance Conceptual Framework Part 2

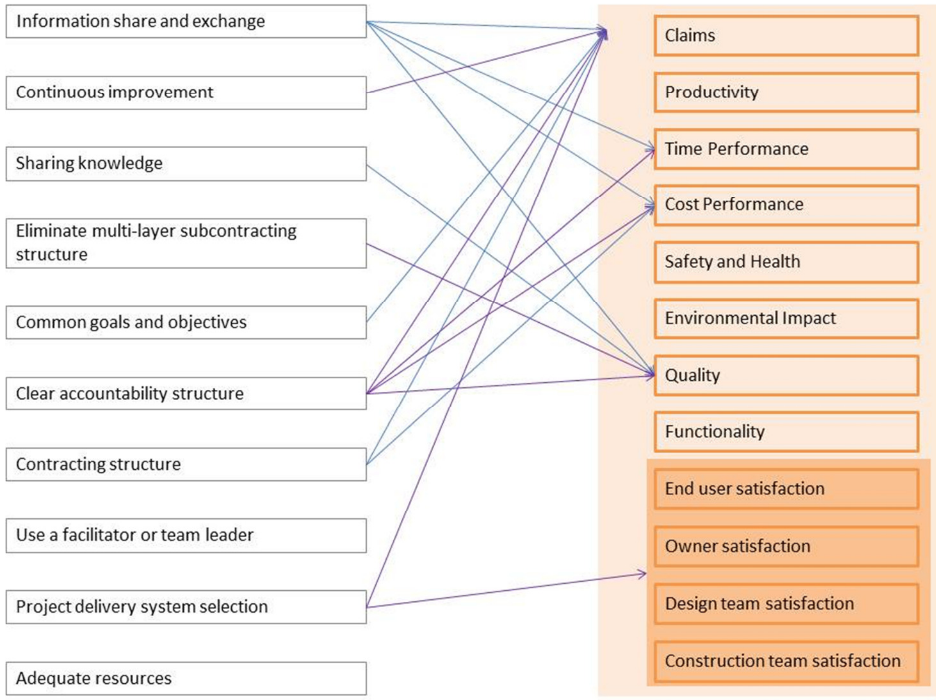

Figure 4- Integration-Performance Conceptual Framework Part 3

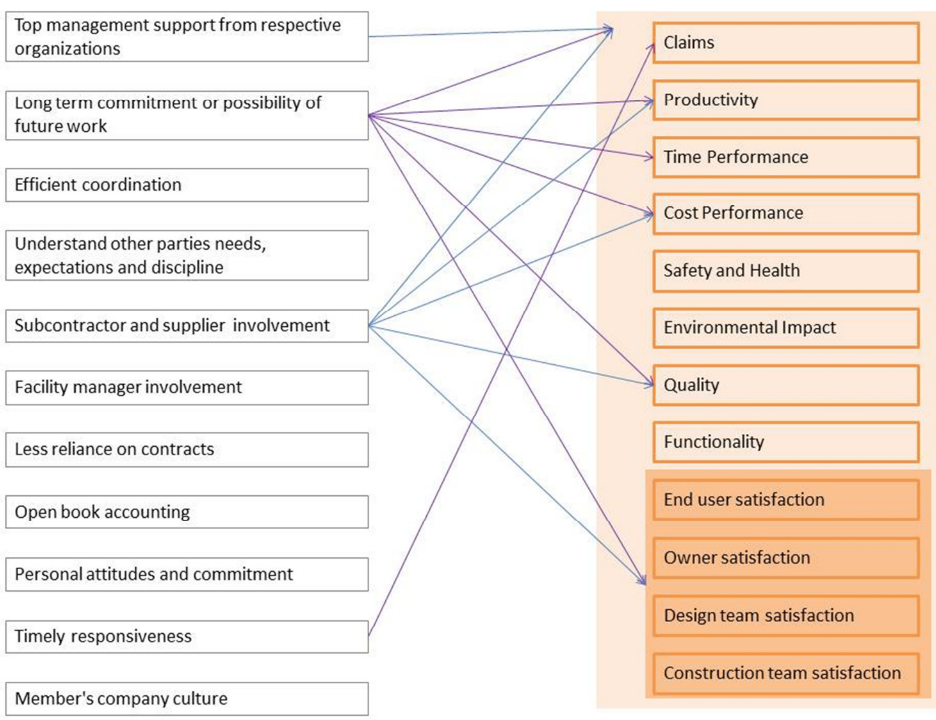

Figure 5- Integration-Performance Conceptual Framework Part 4

CHAPTER 6

METHODOLOGY

In order to achieve the objectives stated in Chapter 4, the methodology described below was conducted. A methodology overview is summarized in Figure 6.

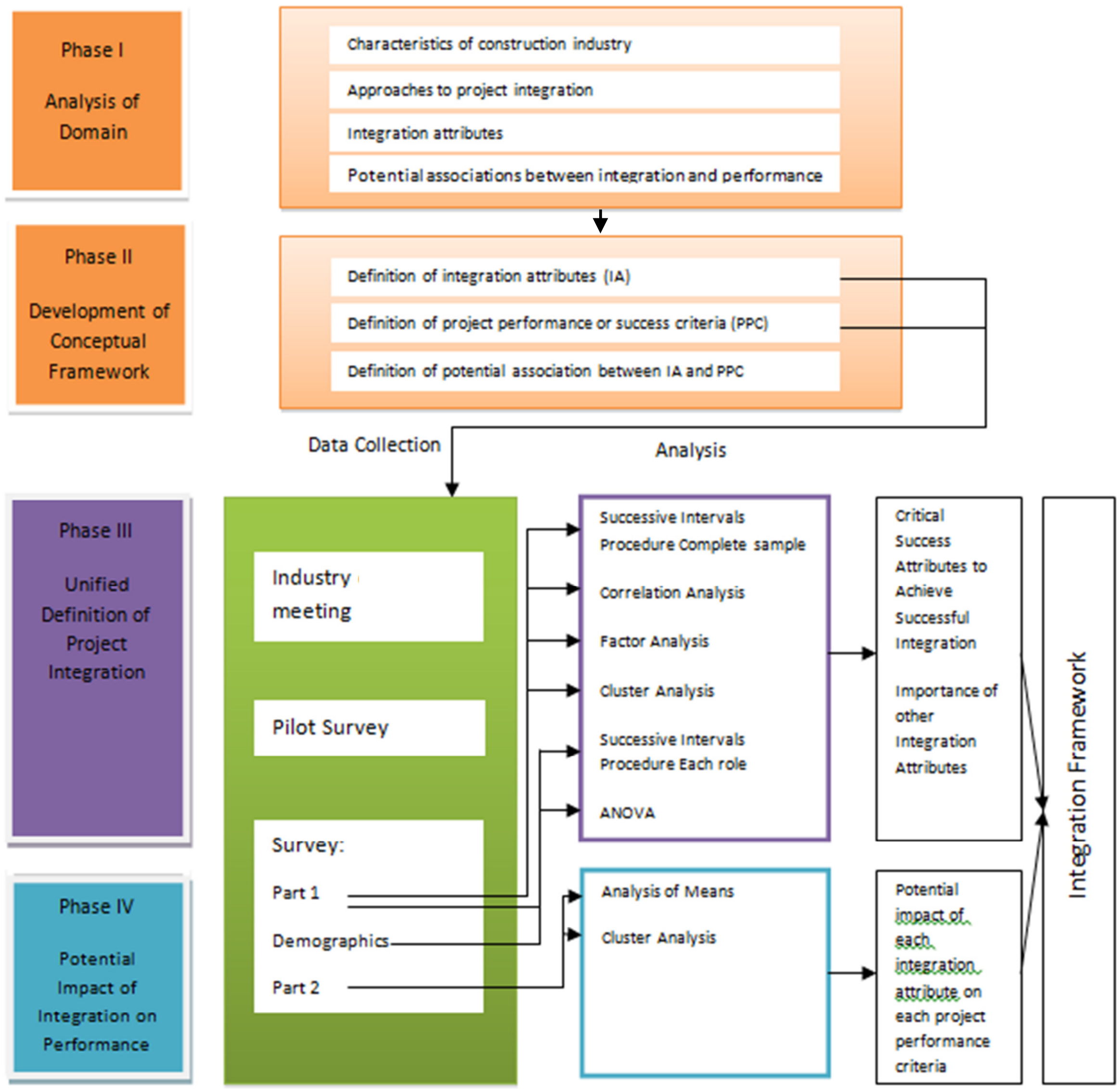

Figure 6-Methodology overview

Literature Review

A comprehensive literature review was conducted to accomplish the following objectives: 1) to understand what are the characteristics of the industry that are preventing it from achieving the desired levels of performance; 2) to recognize the different definitions and approaches to project integration; 3) to identify the attributes that may contribute to project integration; and 4) to determine the conceptual associations between project integration and project performance or project success criteria. Materials from journals, conference papers, refereed publications, research reports, industry reports, PhD dissertations, and industry articles were used to capture background knowledge from researchers and industry practitioners. The information captured through this literature review was used to develop a conceptual framework of project integration and to prepare the questionnaire survey presented below.

Development of a Conceptual Framework

A conceptual framework was developed using the outcomes of a comprehensive literature review. The review identified attributes used by the authors, either in their definition of project integration, or the attributes that they describe as important to achieve project integration. To describe the integration attributes the acronym IA will be used throughout the methodology section. In addition, the potential impact of such attributes on project performance or project success criteria was identified as well. To describe the project performance or project success criteria the acronym PPC will be used throughout the methodology section.

The search covered different perspectives from practitioners and researchers and built a comprehensive collection of attributes. This collection attempts to incorporate views of different groups of people: groups who think that integration can be attained using software to integrate information, groups who think that in order to attain integration it is necessary to change the culture of the construction industry because the problem is associated with behavior or attitudes of practitioners, and groups who think that the main problem is associated with contract language and the way risk is allocated in the contract (implying that the solution would be achieved by having new contracts with shared risk management). It is important to take into consideration that there are some authors whose views fall into more than one category. However, none of the authors studied have covered all the attributes identified. The integration attributes (IA) and the project performance criteria (PPC) are presented in Chapter 5.

In order to present the IAs and their potential impact on PPC, a table and some figures were constructed. The table includes each attribute, the list of authors that have cited the attribute as contributor to project integration, the PPCs that are claimed to be improved by that IA, and the list of authors that have cited that association. The figures depict the IAs and the PPCs and their potential association using arrows. Table and figures are presented in Chapter 5.

Importance of the Integration Attributes for Achieving Project Integration and Identification of Critical Success Attributes Required for Achieving Project Integration

In order to identify critical success attributes required for achieving project integration and their importance, it was necessary to determine which of the IAs identified through literature review, were success attributes critical for achieving project integration (CSIA). In addition, it was necessary to identify the importance of each of the AI for achieving integration.

Data required to develop this part of the analysis was gathered through a questionnaire administer in a survey. A questionnaire was used for this purpose because questionnaires are very good tools to measure the opinions and perceptions of people (Dulami et al. 2002).

Survey Development

The survey was targeted at the largest possible sample of respondents that represent the opinions of stakeholders in the construction industry in different phases of the project lifecycle, thereby including the opinions of owners, architects, engineers and specialty consultants, general contractors, subcontractors and suppliers, facility managers, and other construction industry professionals, such as attorneys, specifiers, and software vendors. The institutional review board (IRB) protocol for the survey was submitted and approved by the Office of Research Compliance at Georgia Tech. The IRB approval is presented in Appendix B.

The link to the survey was sent to members of the Construction Science Research Foundation (CSRF), to alumni of the Building Construction Program (BC) at Georgia Tech, and to different practitioners that showed interest on being part of the study. The CSRF has more than 9,000 members, and the survey was sent through their office in Washington D.C. The database of BC has about 1,000 email addresses, and the link to the survey was sent through the College of Architecture's development office. It was not possible to calculate how many people received the request of the survey, or what the response rate was, as the people who received the survey were also asked to send the survey to other construction industry practitioners or other industry associations that they might know. The questionnaire was distributed in the form of an online survey using the software Fluid Surveys, and it was open for 4 weeks from September 27th to October 22nd 2010.

After the survey was closed, 264 responses were kept as valid; however not all the responses are valid for all of the analysis. Since the survey had two parts in addition to demographics that were used to conduct different analyses, any respondent that had complete responses to at least one of the two parts was retained for further analysis.

Part 1 was related to the importance of each IA to successfully achieve project integration. Questions were asked to determine the importance of each IA with respect to achieving project integration. A brief description of each IA was included to guarantee consistency between respondents. A 9-point rating scale was used to rate the importance of each IA, where the label of 1 was unimportant and the label of 9 was very important. There were not any labels in between these end points, and thus, respondents were free to use the rating scale in a manner that was best suited to the individual judgment styles. Part 2 was related to the potential impact of each IA on each PPC. In this part each respondent was asked to rate the impact of five randomly selected IAs, on each of the 12 PPCs, using a 9-point rating scale, where 1 was no impact at all and 9 was very high impact. The five IAs that were administered to each respondent were randomly selected from all of the IAs under study. A brief description of the definition of the IA and all PPCs were also given as part of the question.

A cover letter that explained the purpose of this research and sought understanding and cooperation of potential respondents was sent along with the link to the online survey. Samples of the cover letter and the consent form are included in Appendix B. Respondents were offered an executive summary of research results. An executive summary will be sent to those interested.

Before developing the questionnaire, a meeting was held with 26 practitioners from the construction industry, to validate whether the IAs identified in literature review encompassed all the attributes required to achieve successful project integration, and whether the identified PPC clearly described project performance or project success criteria. Three new IAs were included as result of this meeting; however the practitioners suggested no additional PPC.

After the industry meeting, but before the questionnaire was distributed, a pilot survey was conducted using Building Construction PhD students and a small number of selected industry practitioners as subjects, in order to identify any potential problems with the survey instrument or if changes were to be made before it was sent out to respondents. Some definitions were modified as suggested by pilot survey participants. In addition, one IA was eliminated and two IAs were split in four IAs. The list of comments from the pilot participants is found in Appendix A. After the industry meeting and the pilot survey, a total of 45 IAs were included as part of the study, and the survey was distributed. A copy of the final survey is found in Appendix C.

Thurstone Scaling Method

The first analysis of the data was based on unidimensional scaling procedure designed originally by L. L. Thurstone (Safir, 1937). In the current context, the scaling method is a type of measurement that assigns numbers to the attributes based on the measured perception of importance of the attribute for achieving project integration. The particular scaling method used in this study is known as the successive interval procedure. This method is based on Thurstone's law of categorical judgment that allows determining interval-level scale values from rating data that are, at best, on an ordinal level of measurement (Torgerson 1958). The basic idea behind this method is to place the rating scale points or the perception of an individual on an unobservable evaluative continuum which is often referred to as the psychological continuum or the latent continuum.

The theory underlying the successive intervals procedure is based on the notion that there is variability in how individuals perceive stimuli (i.e., integration attributes) in the physical world. When an individual is given a specific number of rating categories, the individual locates those categories on an underlying psychological continuum. Moreover, the individual separates those categories by category boundaries which are also located on the psychological continuum and are generally not equally spaced. These locations are simply the individual's perceptions of where each category boundary is located on the evaluative continuum. The exact location of the category boundaries can vary from one individual to another and it is assumed that the perception of all the respondents in regard to the location of each category boundary has a normal distribution. The mode of the distribution of each category boundary is the location of the category boundary on the evaluative continuum (Torgerson 1958).

In addition to their perceptions of category boundaries, the theory of categorical judgment also presumes that subjects locate stimuli (i.e., integration attributes) on the same evaluative continuum. Again, these perceived locations vary across subjects and this variance is presumed to give rise to a normal distribution of perceptions for each attribute. In the current study, respondents were asked to locate each attribute according to its perceived importance with respect to achieving integration. The mode associated with each attribute's distribution is the "scale value" for that attribute.

A graphical representation of the concept of category boundaries and of scale values is presented in Figure 7.

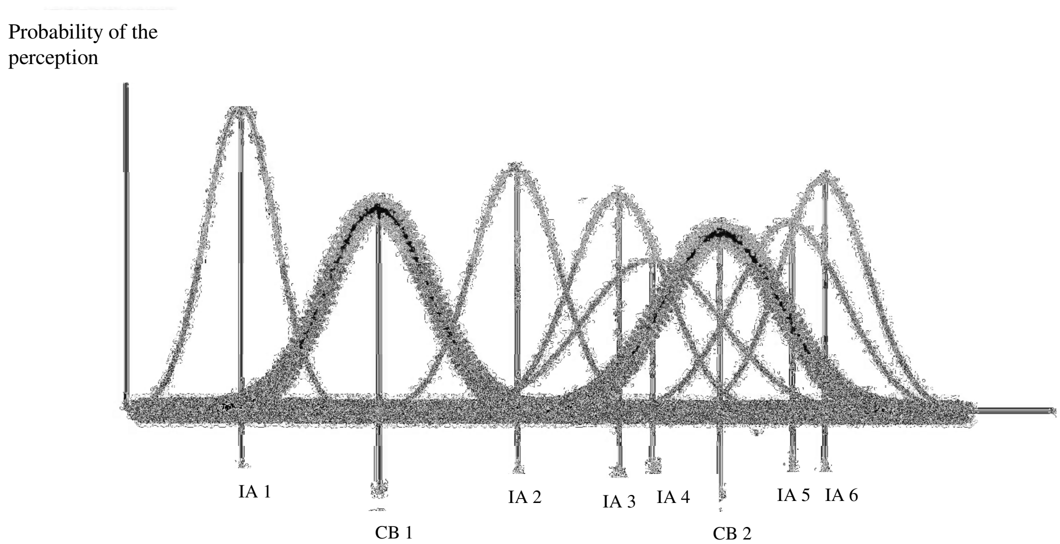

Figure 7-Example of how category boundaries are defined

Figure 7 illustrates a simple example case of successive interval procedure for three rating scale categories and six attributes. The category boundaries falling between the three rating scale categories are denoted as CB1 and CB2. These are simply the modes of the normal distributions corresponding to the locations of the category boundaries. (Again, the perceptions of these distributions vary across respondents and are presumed to form normal distributions). Each attributes' importance to integration will also vary across subjects and is assumed to follow a normal distribution. These distributions have modes at the locations in Figure 7 labeled as IA1 through IA6, respectively. These modes constitute the scale values for the attributes in this illustration. In short, the successive intervals procedure provides a mechanism to estimate the modes of both the category boundary and attribute distributions based on the original responses to the rating scale. These modes are positions on an underlying continuum that are on an interval level of measurement.

It is also necessary to note that the scenario portrayed in Figure 7, and the form of the model used in this study, corresponds to what Torgerson (1958) referred to as Case 2 of the Law of Categorical Judgment. Case 2 assumes that correlation between the perceptions of category boundaries and attribute importance is zero. In addition, it assumes that the variance of each category boundary distribution is constant across category boundaries (Torgerson 1958). In contrast, the distributions of perceptions of attribute locations are allowed to have different variances.

When the distribution assumptions of the successive interval procedure hold, then the procedure yields an interval scale on which each category boundary and IA is located. To check the assumptions of the model a plot of the probits against the scale values is performed and regression lines are constructed separately for each category boundary value. A probit is the inverse of the cumulative distribution at a certain probability for a standard normal distribution, so it is the Z-score associated with certain probability value. The probits are calculated for the cumulative proportions of each rating category for each attribute. The probits are used to check the normality assumptions. If the plot of the probits against the scale values is approximately linear for a given category boundary, it provides empirical support that the perceptions of the location for that category boundary follow a normal distribution across respondents. In addition, if the regression lines are approximately parallel, then one can assume that the variances of the category boundary distributions are constant (Torgerson, 1958). Similar plots of probits against category boundaries are also constructed and a regression line is calculated separately for each attribute. An approximately linear relationship between probits and category boundaries suggests that the perceptions of attribute locations on the evaluative continuum are normally distributed. If these regression lines are parallel across stimuli, then the variance of perceived attribute locations is constant across attributes. However, this assumption is not made in the Case 2 formulation of the model, and indeed, the variance of each attribute distribution are freely estimated.

As mentioned previously, when the rating data adhere to the assumptions of the successive intervals model, then the category boundaries and attribute scale values represent positions on an interval-level measurement scale. All interval-level measurement scales have an arbitrary origin and unit. The origin and unit were assigned in the current study by fixing the first two category boundaries at 0 and 1, respectively. This is consistent with the method presented by Torgerson (1958)

A particular category boundary was used to operationally define which attributes are critical to successful project integration; these attributes are labeled as CSIA. The category boundary selected to determine the CSIAs was the boundary that separated the response categories 7 and 8. This strategy yielded CSIA-type attributes that were generally rated as 8 and 9 on the observed rating scale of importance for project integration.

Correlation Analysis

To confirm if the scaling procedure used was a good model to represent the data obtained, a correlation analysis was performed between the scale values and the mean of each of the IAs importance ratings. Two different types of correlations were calculated.

One was the Pearson correlation and the other was the Spearman rank order correlation. The Pearson correlation is based on the linear relationship between two variables, while the Spearman rank order correlation measures the extent to which one variable increases or decreases as the other variable increases or decreases (i.e., it assessed the strength of a monotonic relationship between two variables).

Factor Analysis

In order to identify the different dimensions of project integration, a factor analysis also was performed on the importance ratings for the IAs. First, a principal components analysis was conducted to determine the number of dimensions that account for maximum variance in ratings of IAs importance. A principal components analysis is based on mathematically defined linear combinations of the observed variables. It is a projection of the original variables on new axes that are orthogonal and depict the directions of maximum variation. There are as many components as original variables. The first component accounts for the maximum variation, the second accounts for the maximum variation not accounted for by the first one, and so on. One of the functions of this analysis is to determine the dimensionality of a set of measures by determining the number of dominant components that are present. To determine the number of dominant components there are several criteria. For the purpose of this study, the criterion that was used to determine the number of principal components is a bootstrapped of parallel analysis criterion. The main idea behind this criterion is to generate a reference set of eigenvalues by randomly selecting values form the sample and running the analysis several times, and then the generated reference set of eigenvalues is compared to the observed eigenvalues. The number of components to retain, is the number where both sets of eigenvalues cross (Stevens 2009). The only result used from this analysis was the number of dominant principal components or dimensions.

Second, an exploratory factor analysis was conducted using the number of dimensions obtained in the principal components analysis. A factor analysis is an analysis that attempts to uncover the latent structure of a set of variables. Thus it reduces a group of variables, in this case each IA, to a smaller number of factors. It is based on solving a set of regression equations where each of the original variables is treated as a dependent variable that is explained by a set of latent factors that are treated as the independent variables. The original variable is explained in terms of the linear combination of these common latent factors, which account for the covariation among the observed variables and the variation of each variable that is common, plus a unique factor, that is the portion of the variance that cannot be predicted by the common factors. The extraction method used was principal axis factoring with 4 iterations. An oblique Promax rotation was subsequently performed, to allow for correlations among the common factors that were initially extracted.

Cluster Analysis

In order to visualize if there were different patterns of behavior on the responses, a cluster analysis was conducted. A cluster analysis was used to divide the IAs according to the similarity of responses across respondents. IAs that were in one cluster were rated more similar across respondents than were IAs placed in another cluster. The type of analysis used was an agglomerative hierarchical cluster analysis, where the grouping procedure occurs in stages, and the result of one stage is used on the following stage. Thus in the first stage each IA constitutes a single cluster. Then, on each of the subsequent stages, two clusters are combined depending on the degree of similarity. Distances between rating profiles are used as estimates of dissimilarities, and clusters with the least dissimilarity are combined until there is just one giant cluster. The linkage method used is called average linkage. This method joins two clusters when the average distance between any of the elements of one cluster with respect to the elements of the other cluster is smallest when considering all pairs of clusters (Stevens 2009).

In order to determine the number of clusters to retain, three statistics were analyzed: the cubic clustering criterion, the pseudo-F statistic and the pseudo-t^2 statistic. The main objective of the cubic clustering criterion is to comparatively measure the deviation of the clusters from a distribution where no clusters exist in the data, therefore large positive values of this criterion indicate that the obtained solution differs more from the no cluster solution and the number of clusters according to this criterion is the number of cluster where a local maxima exists. The main objective of the pseudo-F statistic is to measure how each cluster is dispersed from each other, therefore larger numbers of this statistic indicate that the clusters are more dispersed, so the number of clusters to retain is the number of clusters that maximize the pseudo-f statistic, or where a local maxima exists. The main objective of the pseudo-t^2 statistic is to determine the relative increase in error sum of squares when two clusters are combined in a hierarchical analysis. When using this statistic the desired number of clusters of the analysis is the number of clusters where a local minima of the pseudo-t^2 exists followed by a larger value.

As part of this analysis a dendrogram was produced to illustrate which IAs belong to each cluster. A dendrogram is a graphical representation of how the attributes have been combined in the different stages of the hierarchical clustering process. It is based on a tree diagram, in which, the root represents a one cluster solution. Levels of the tree indicate the distance between the two clusters joined at that level in the hierarchical clustering process. When clusters that are relatively more distant are joined, then this is an indication that the optimal number of clusters for the solution has been exceeded.

Identification of Differences in the Perception of Critical Success Attributes and Their Importance Depending on the Role of the Project Participant in the Industry

In order to identify differences in the perception of critical success attributes and their importance depending on the role of project participants in the industry, it was necessary to identify if there were differences in the perceptions of Owners, Architects, Engineers or Specialty Consultants, General Contractors, Subcontractors or Suppliers, and Facility Managers on the CSIA and their importance.

Data required to develop this part of the analysis were from of Part 1 of the survey and in the demographics section of the survey. In the demographic section respondents were asked to categorize their participation in the construction industry in one of the following groups: Owner, Architect, Engineer or Specialty Consultant, General Contractor, Subcontractor or Supplier, Facility Manager. In Part 1 they were asked to rate the importance of each IA to attain successful project integration.

Thurstone Scaling Method

To meet this objective, two different analyses were performed. First, one scale was built for each group using the successive intervals procedure explained previously, and the results were plotted. This analysis provides a graphical and numerical representation of how each different group perceives the importance of each IA to achieve project integration. In addition, the same category boundary previously selected to operationally define which attributes are CSIAs was again used to identify CSIAs separately in each group. Classifications of CSIAs were compared across the analysis for each group along with that from the total sample.

Analysis of Variance

In order to determine if there were statistically significant differences between groups in their average perception of the importance of each IA, a between subjects analysis of variance (ANOVA) was performed on the importance of IAs importance as a function of the role of the project participant in the industry. ANOVA had to be used instead of a multivariate analysis of variance (MANOVA), because the number of subjects in some of the occupation groups was smaller than the number of IA.

An ANOVA using an alpha equal to 0.05 was run for each IA. Type I error across all IAs was not controlled because the reference p-value would have been too harsh. For example, the Bonferronni technique to control Type I error across IAs, would divide alpha by 45 yielding a significance level of 0.0011. This tactic seemed too extreme for an exploratory analysis such as this, so the Type I error was simply controlled separately for each univariate analysis.

Identification of Any Perceived Impact of Integration Attributes on Performance Factors of Project Success Criteria

In order to identify any perceived impact of the integration attributes on performance factors or project success criteria, data from Parts 1 and 2 of the survey were used. The second part of the survey asked each respondent to rate the potential impact of IAs on each of the 12 PPC. In order to make the time demand reasonable for each survey participant, these ratings were obtained for only five randomly selected IAs from the complete set of 45 IAs. Randomization was performed independently for each participant.

In order to identify patterns of potential impact of the different IAs on PPCs, two different analyses were performed: an analysis of the mean impact on each PPC of the IA and an analysis of the mean clusters of IAs that were formed by clustering IAs by their PPCs profiles.

Analysis of the Means of Attributes

Means, standard deviations and standard error of the means were calculated for each PPC rating separately for each IA. The mean PPC rating was plotted across IAs to identify patterns and outliers.

Analysis of the Means of Clusters of Attributes

IAs were grouped depending on the similarity of their means across PPCs using a hierarchical cluster analysis. This clustering procedure was identical to that explained before. The mean of each cluster was calculated and was plotted for each PPC. The means for each cluster with respect to each PPC were analyzed.

CHAPTER 7

SURVEY DEVELOPMENT

A survey was developed to collect the data required to conduct this study. In order to develop the survey several steps took place. First, a meeting was held with industry practitioners to validate the attributes and the performance criteria that were going to be used for the study; second, a pilot survey was conducted to get feedback before the survey was sent out; and third, the final survey was refined and finalized.

Industry meeting

A session on "Construction Project Integration and Its Impact on Performance" was held as part of an industry symposium that took place at the Georgia Institute of Technology on June 14th 2010. It was chaired by Angelica Ospina and Daniel Castro. The description used to invite symposium participants to attend the session was: "A conceptual framework that identifies the attributes required to achieve successful project integration and their potential associations with project performance will be presented, followed by a discussion of industry experts on this topic."

Twenty-six (26) attendees participated in the session. The conceptual framework of this study was presented and was provided to participants. After a brief presentation, participants were asked to analyze the document that was handed out, and to write down their comments, paying special attention to the completeness of both the list of integration attributes and the list of project performance criteria. After participants wrote down their comments, the discussion was open and the participants shared their views with the rest of the group. At the end of the session participants were asked to return the document with their comments.

For the most part participants agreed with the attributes and performance criteria that had been previously identified; however they thought that it was very important to include three other attributes. One was the use of a shared BIM. Previous to this meeting, the use of BIM and a shared BIM, was included as part of the attribute “adequate use of technology”; however participants considered that it was very important to treat this as a separate attribute. The second was “team experience”, as participants thought that an integrated process is enhanced when people involved in it have experience working in a team environment. And third, “project type experience”, as participants thought that when project members have experience in the type of project that is to be developed, the integration process is smoother. The participants considered that the performance criteria selected adequately encompass the different aspects that should be evaluated in a construction project.

Pilot Survey

After conducting the session at the construction industry symposium, the first draft of the survey was developed. PhD students of the Georgia Institute of Technology and a small number of practitioners from the AEC (architecture, engineering and construction) industry were subsequently invited to be part of the pilot survey. The pilot survey was conducted using the same online system that was going to be used with the complete sample of respondents. This enabled the detection of any problems with the deployment system, which was based on the online software known as Fluid Survey.

Fifteen respondents participated in the pilot survey. Each of these respondents was asked to answer the survey and to provide feedback on the following issues, as described in the instructions:

1 Time required for completing the survey: if you stop at any time to take notes, I would like to ask you to record the time you started and stopped or use a stop watch.

2 Clarity of the instructions.

3 Clarity of the definitions: If you want to give me feedback on a specific definition, please write down the name of the definition and then your comments (in case you stop to write down any specific comment before finishing the survey, please make sure to have track of the time).

4 Any problems with the website: for instance crashes, times you have to restart, any other problems.

5 Other comments

The comments from the 15 respondents were analyzed. A list of all received comments is presented in Appendix A. Most comments dealt with the clarity of the definitions and with explaining both parts of the survey. However there were some comments related to the attributes. As a result of considering suggestions from pilot participants, the attribute “mutual respect and trust” was split into two different attributes: “mutual respect” and a separate one for “trust”; the attribute “involvement and commitment of a knowledgeable owner” was split into two attributes as well, one for “involvement of a knowledgeable owner”, and a separate one for “commitment of the owner”; and finally the attribute “collaborative process” was removed from the study.

Final Survey

The final survey included the feedback from the industry meeting and from the pilot respondents. As described in the Methodology, the survey had a demographics section, Part 1 that was related to the importance of each of the 45 integration attributes (IAs) for successfully achieving integration, and Part 2 was related to the potential impact of each of the IAs on each of the 12 project success or performance criteria (PPCs). In order for the survey to be completed in 25 minutes, Part 2 included the rating of five IAs for the 12 PPCs for each respondent. These five IAs were randomly selected from the list of 45 possible IAs. In addition, Part 1 and Part 2 were presented in random order, for each respondent. Demographic questions were always presented before either Parts 1 or 2. All the IAs in Part 1 of the survey were always presented in random order to the respondents. In addition the PPCs we always presented also in random order for each IA.

It was very important to give a definition for each of the IAs and PPCs, to enhance consistency among respondents. In addition these definitions are very important to understand the results of this study. In addition, there were some questions regarding building information modeling, and on each of these questions there was a note that said that if the respondent was not familiar with the term “building information modeling”, then the person should skip the question. The complete survey is presented in Appendix C; however the definitions of each attribute are presented in Table 6 and the definitions of how the different performance criteria should be measured are presented in Table 7.

Table 6- Definitions of integration attributes

Attribute	Definition
Team experience	Experience of the team and each individual in project integration
Members' company culture	Internal culture of collaboration and teamwork with other companies that each company should have
Timely responsiveness	Having in place a short response time for the inquiries that arise from different parties.
Personal attitude and commitment	Individual internal motivation to change processes and to improvement, including a change in attitude, mindset and commitment, by developing personal relationships with their counter parts and understand the motivations of the entire team. These changes are required from every person who is involved in the process at all levels, from the working-level people working at the jobsite on a daily basis to the top management.
Open book accounting	Having in place a transparent financial structure where all expenses and costs are explicit to team members, helping on building trust between the team, reducing reliance on bidding and contracts themselves, and keeping all team members accountable for their participation in the project
Less reliance in contracts	Ability of the team to interact, collaborate and support the project beyond the contract requirements and constraints.
Facility manager involvement	Involvement of the facility manager as part of the project team key players early in the process as they are ones who know the requirements of maintenance and operations as well as the expectations of final users.
Subcontractor and supplier involvement	Involvement of subcontractors and suppliers as part of the project team key players early in the process as they are the ones who are actually performing the work on field.
Understanding of other parties' needs, expectations and disciplines	Ability of each party to understand the goals, objectives, mission, needs, technologies, finances and operations, and disciplines of other participants.
Efficient coordination	Ability of the entire team of combining all project parts in a way that they do not present conflict. It can be achieved by sharing project information and by facilitating points of contact between the different parties.
Long term commitment	Commitment of the different parties to work together in future work, thereby parties can balance the attainment of short term objectives with long-term goals; reducing the fear for opportunistic behavior, eliminating waste in the process, and improving projects by learning from experience.
Support from top management	Commitment and belief in an integrated process of top management from parent organization of team members, who formulate the strategy and the direction of business activities.
Adequate resources	Availability of resources in terms of knowledge, technology, information, specific skills, capital and time when needed.
Project delivery method selection	Selection of the method that determines relationship and interactions between project members.

Table 6-Continued

Attribute	Definition
Use of facilitator	Having a person who can help develop communication skills, foster respect and trust, guide the project team in the integration process, align individual goals and project goals, eliminate the fear of conflict, get commitment from the different stakeholders, make each party accountable for their responsibilities, and have leadership skills.
Contracting structure that fosters collaboration	Agreement that sets how the different parties are going to interact in the project and who is responsible to whom, in a way that fosters collaboration and communication, integrating the efforts of the entire team.
Clear responsibilities and clear accountability structure	Structure defined up front that explicitly states responsibilities within the project and how those responsibilities will be assessed as the project progresses.
Common goals and objectives	Alignment between project goals, stakeholders' goals and individual's goals.
Eliminate multilayer subcontracting structure	Structure where the general contractor or the project manager hires directly the subcontractor that is going to perform the work increasing the accountability of parties involved.
Knowledge sharing	Exchange of talent and knowledge between team members by exchanging ideas and attacking problems simultaneously from different disciplines.
Continuous improvement	Ability and capability to improve as the project progresses and after the project is over in order to generate knowledge and to transfer knowledge, therefore decisions should be evaluated at different stages of the project in an iterative process that helps those decisions reflect broad team knowledge and the understanding of all interactions, feedback should exist, lessons learned should be evaluated during the project and after it, and a post project evaluation should exists.
Information share and exchange	Open, quick, effective and free flow of information from one organization to the other and among team members.
Organization and project manager leadership	The belief, attitude and commitment of the project manager and other leaders of the project towards integration in order to encourage integration and to motivate the team.
Project type experience	Experience of the team and each individual with the type of project that is being developed.
Open and continuous communication	Maintaining open and direct lines of communication between all project participants at all times, with no restrictions because of roles within the team.
One team one location	Setting a certain place where team members can move to work in a collaborative environment where communication is facilitated and skills and knowledge are combined in a group.
Commitment of the owner	The understanding and belief of the owner on the integrated project process and of its benefits; thereby demanding the change of the industry practitioners.

Table 6-Continued

Attribute	Definition
Intensive involvement of a knowledgeable owner	Active role the owner should have during the design and construction, because when the owner is involved, regular feedback exists between the owner and the rest of the team.
Shared building information model	The use of one building model that has the input of all team members and that can be used by all team members.
Appropriate use of technology	The extensive use of software products to integrate the project phases, the project process, to exchange information and to improve communication.
Reward structure linked to the success of the project	Payment or reward structure that links the financial success of each project member to the success of the project, because it is essential for each party to recognize that they are going to succeed if the performance of other team members is successful and that they are not going to be penalized for bringing more efficient solutions to the project.
Early goal and objectives definition	Having in place a strategy to clearly set goals and objectives early in the process, and to help team members to understand them and to agree on them; because when goals are ambiguous for team members, the outcomes will not reflect what the project expects.
Intensified planning	Setting the project phases in a way that more time and effort is allocated to the planning phase and to other earlier phases because most of the analysis and decision making process should take place early, when there is greater opportunity for making more cost effective decisions with better financial impact.
Collaborative decision making	Procedure of decision making based on the knowledge of the facts and points of view of the different team members to make the best decisions in the best interest of the project; therefore, ideas should be evaluated by the project team and consensus should be encouraged.
Team selection criteria and procedure	Procedure of team selection not solely cost-based, but that includes other relevant criteria such as qualifications, previous experience, ability and commitment to participate in an integrated team, willingness to commit to shared-risk ideas, open communication and creation of a no-blame culture. Thereby price should be discussed after the team has been selected.
Team-building and teamwork	Having in place strategies to encourage interdisciplinary groups where team members can contribute beyond their profession, by building relationships and trust among them. It is not putting different firms to work together as separate disciplines with different objectives.
Early involvement of key project participants	Bringing on board the most important project participants early in the process to improve the input of knowledge and expertise in the stages of the process when decisions are less costly and more effective.
Innovation and innovative thinking	Process where ideas can be freely exchanged and are not evaluated according to the role of the person in the project; stimulating innovation and having an open mind to accept ideas from others to reach optimized solutions.
Training and education	Desired characteristic of the people involved in the project, because team members should be trained and educated not only on the specific knowledge and skills of their trade, but also in the knowledge and skills of teamwork.

Table 6-Continued

Attribute	Definition
Clear benefits for all members involved	Process that has benefits that are clear upfront for all parties in the supply chain in line with the value they add to the process.
Trust	Reliance of one party on another because expectations are met repeatedly and each party knows that others are reliable in fulfilling their obligations.
Atmosphere of mutual respect	Work environment characterized by ethical and honest behavior, with a no-blame culture, equitable relationships, and fairness.
Performance oriented culture	Setting performance of the project and performance of the team as important objectives that are continuously measured and assessed against clear targets.
Internal conflict and dispute resolution	Use of joint problem and conflict solving strategies that look for mutually satisfactory solutions and that seek alternatives for problematic issues.
Adequate risk management	Establishment of a risk sharing structure whose main goal should be to minimize the overall project risk instead of shifting the risk from one party to the other.

Table 7- Definitions of measurement of project performance criteria

Performance Criteria	Definition of Measurement
Claims and litigation	Measured as economic damages resulting from claims and disputes
Construction team satisfaction	Subjective measure of how the construction team feels when working on the project and how the project fulfills its expectations.
Cost performance	Measured using the indicators of unit cost, percentage of cost variation relative to the budget, and net present value.
Design team satisfaction	Subjective measure of how the design team feels when working on the project and how the project fulfills its expectations.
Environmental impact and sustainability	Measured using the criteria of the LEED certification or the ISO 14000 standard.
Functionality	Subjective measure of how a project fulfills its intended function.
Health and safety	Measured using the indicator of number of accidents per number of man hours worked on a project
Owner satisfaction	Subjective measure of how the owner feels when working on the project, how the project fulfills owner's expectations, and how likely the owner is to work with the same team in future projects.
Productivity	Measure of output per unit of input, and is measured as the ratio of square footage per labor hour.
Quality	Subjective measure defined as the achievement of features required to satisfy expectations of the owner, and is measured as the extent of meeting specifications.
Time performance	Measured using the indicators of construction time, speed of construction relative to square footage, and percentage of time variation relative to the schedule.
User satisfaction	Subjective measure of how a project satisfies the final user expectations.

CHAPTER 8

RESULTS AND ANALYSIS: PROJECT INTEGRATION

Survey Sample

264 responses were obtained as result of the survey. As explained in the Methodology Chapter, the survey had 2 parts in addition to demographics. Data from each part of the survey was used to conduct different analyses; every survey that had any of the two parts without missing data was kept as valid.

The survey was targeted to practitioners of the AEC industry who have different roles in a project. From the 264 responses obtained, 38 were owners (14%), 56 were architects (21%), 87 were engineers or specialty consultants (33%), 48 were general contractors (18%), 13 were subcontractors or suppliers (5%), 8 were facility managers (3%), and 14 respondents reported their role as other (5%). A graphical representation of the percentage of respondents for each role is presented in Figure 8.

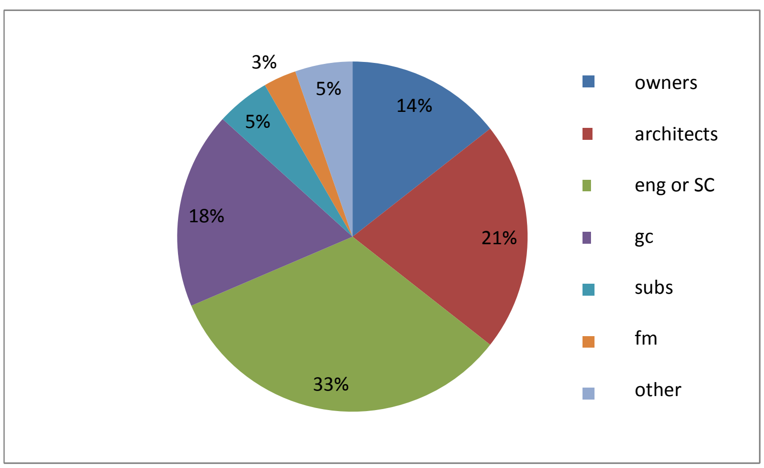

Figure 8- Percentage of respondents by role

In terms of the size of the firm where respondents worked at the time of responding the survey, 6 respondents did not respond (2%), 40 respondents worked in a company with annual revenue of less than $250,000 (15%), 33 in a company with an annual revenue between $250,000 and 1 million (13%), 56 in a company with a revenue between $1 million and $ 5 million (21%), 38 in a company with a revenue between $5 million and $25 million (14%), 13 in a company with annual revenue between $25 million and $50 million (5%), 24 in a company with an annual revenue between $50 million and $250 million (9%), 31 in a company which annual revenue is between $250 million and $5 billion (12%), and 23 in a company of a revenue of more than $5 billion (9%). A graphical representation of the distribution of respondents in terms of the size of the company where they worked at the time of responding the survey is presented in Figure 9.

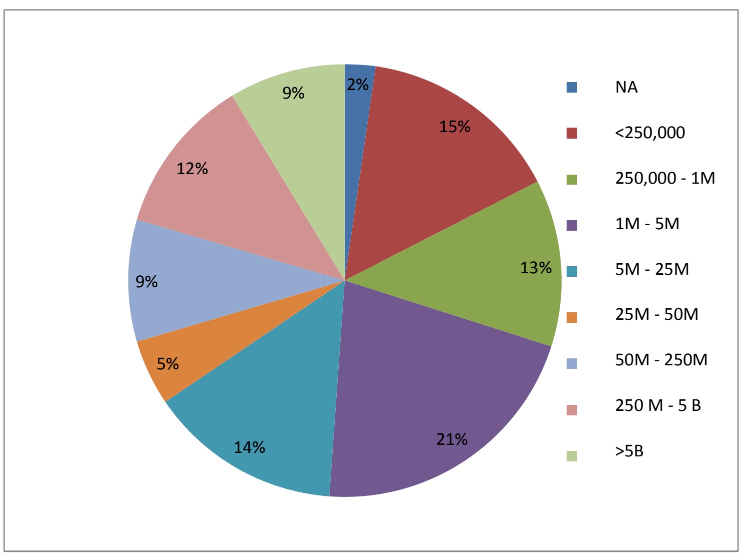

Figure 9- Percentage of respondents by company size

In terms of the sector the sector of the industry where respondents worked at the time they took the survey, 4 respondents did not respond (2%), 12 respondents worked in more than one sector (5%), 104 respondents worked in the commercial sector (39%), 68 respondents in the institutional sector (26%), 17 in the residential sector (6%), 44 in the civil sector (17%), and 15 in the industrial sector (6%). A graphical representation of the sectors or the industry where respondents worked at the time they responded the survey is presented in Figure 10.

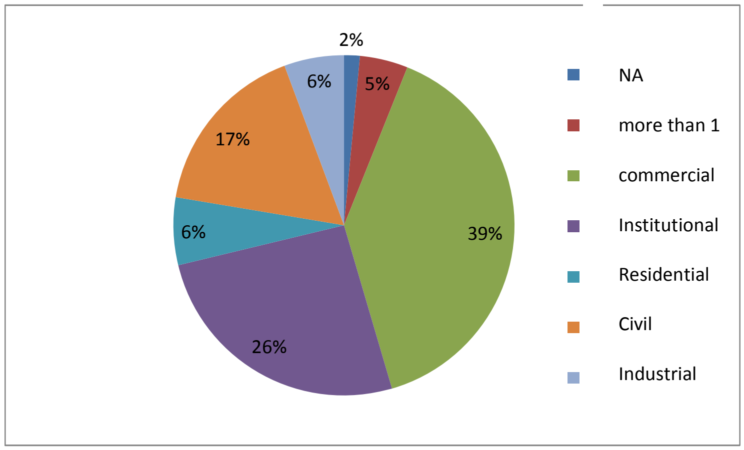

Figure 10- Percentage of respondents by industry sector

Finally, from the sample 243 (92%) respondents had construction project related experience at the time they responded the survey, while 21 (8%) respondents did not.

From the demographic information it can be concluded that most of the different roles that compose the members of a project team were represented in the sample of the survey; however, the representation of facility managers and subcontractors and suppliers was small, therefore they had to be grouped with owners, and general contractors, respectively for the purpose of the analysis. In addition, there were respondents that belonged to companies of a wide variety of sizes. In terms of the sector, most of the respondent worked in the commercial and institutional sectors; however there was a considerable representation from the civil sector.

Importance of the Different Attributes for Achieving Project Integration

In order to develop an integration framework that can be used as a decision making tool for improving integration at project level, it is important to identify the integration attributes (IAs) that are very important for achieving project integration or the critical success attributes for achieving project integration (CSIAs); in addition, it is very important to identify the IAs that have a low level of importance for achieving project integration or that are neutral for achieving project integration. Because if an integrated project is to be achieved, more resources should be allocated for implementing the CSIA, while less resources, if any, should be allocated for implement IAs that have a low level of importance.

The analysis was performed first based on the responses of the complete group of respondents and second based on the responses grouped by the role of the respondents, to identify if there are major differences across the perception of different groups of respondents.

Data used for this section of the analysis was gathered using demographics and Part 1 of the survey. The number of responses without any missing data for Part 1 was 218 responses.

Complete Group of Respondents

To analyze the importance of the different integration attributes (IAs) for achieving project integration according to the perception of the complete group of respondents, four different analyses were conducted; Thurstone's successive interval procedure scaling method, correlation analysis, factor analysis, and cluster analysis. The results and the discussion of the results of those analyses are presented on the following sections.

Thurstone’s Successive Interval Procedure Scaling Method for Nine Rating Categories

In order to understand the importance of each attribute for successfully achieving project integration (according to the perception of project participants from the industry) the successive interval procedure was used. The CATJUG program developed by Roberts (2010) is a Statistical Analysis Software (SAS) macro program used to scale perception responses using the Thurstone’s successive interval procedure. This program was run considering the ratings given by industry practitioners. They were asked to rate from 0 to 9 the importance of each of the attributes under study in order to achieve project integration.

As mentioned in the Methodology Chapter, the successive interval procedure is used to scale the perception of respondents using an interval scale, converting the ordinal measures of the rating scale, to an interval measure. In an interval scale one unit represents the same magnitude on the perception of respondents across the scale, therefore the difference for instance between 1 and 2 is the same difference between 4 and 5. It was important to convert the ordinal rating scale to an interval scale, because an ordinal scale just describes the order, not the magnitude of the difference of the items that are being measured, while the interval scale describes the magnitude of the difference. Therefore, the method used helped to uncover metric data form ordinal judgments.

Using the successive interval procedure the category boundaries and the scale values for each attribute for the data obtained in Part 1 of the survey were calculated. An interval scale does not have origin or unit, therefore the zero was arbitrarily selected to be the first category boundary, and in addition the unit was selected to be the distance between category boundary 1 and category boundary 2. Therefore, the other category boundaries and the scale value for each attribute are located on the scale with respect to this arbitrary zero and unit selected. Thus, category boundary 1 is between rating values 1 and 2, category boundary 2 is between rating values 2 and 3, and so on. A graphical representation of the category boundaries and the rating values is presented in Figure 11. The category boundaries for this analysis are presented in Table 8 and the scale values and the standard deviations of the distribution of the perceptions for each IA are presented in Table 9. The complete results of the analysis are presented in Appendix D.

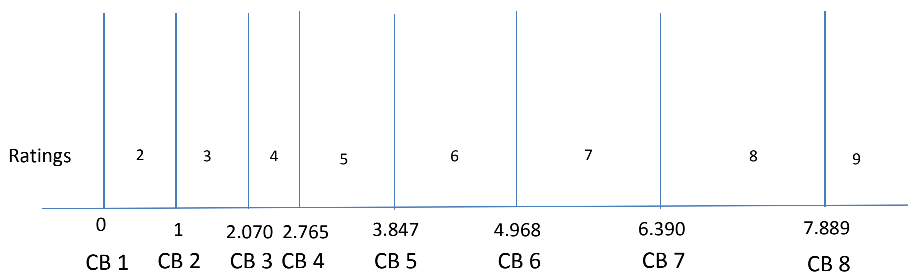

Figure 11- Graphical representation of the category boundaries, analysis performed with nine rating categories

Table 8- Category boundaries, analysis run with nine rating categories

Category Boundary	1	2	3	4	5	6	7	8
Category boundary Value	0	1	2.070	2.765	3.847	4.968	6.390	7.889

Table 9- Scale value and standard deviation for each IA, analysis performed with nine rating categories

Attribute	Scale Value	Standard Deviation
Open and continuous communication	7.998	2.18
Category Boundary 8= 7.889		
Early involvement of key project participants	7.735	2.307
Organization and project manager leadership	7.636	1.878
Information share and exchange	7.508	1.878
Trust	7.463	2.22
Timely responsiveness	7.384	1.857
Owner commitment	7.271	1.98
Personal attitude and commitment	7.199	2.123
Efficient coordination	7.185	2.05
Adequate resources	7.139	1.685
Top management support	7.104	2.184
Atmosphere of mutual respect	7.093	1.996
Clear responsibilities and accountability structure	7.055	1.946
Early goal definition	7.005	2.117
Knowledge share	6.905	2.161
Common goals and objectives	6.802	2.305
Team selection criteria	6.746	1.924
Intensified planning	6.553	2.306
Contracting structure that fosters collaboration	6.524	2.303
Category Boundary 7= 6.390		
Understanding other’s needs and expectations, and disciplines	6.389	1.77
Internal conflict and dispute resolution	6.318	1.803
Collaborative decision making	6.285	2.168
Subcontractor involvement	6.232	1.946
Team building and teamwork	6.127	2.182
Intensive involvement of a knowledgeable owner	6.121	2.322
Adequate risk management	6.077	2.157
Performance oriented culture	6.075	2.054
Training and education	6.063	2.281
Appropriate use of technology	6.063	2.156
Innovation and innovative thinking	6.062	2.254
Team experience	5.999	1.971
Member’s company culture	5.972	2.301
Facility manager involvement	5.848	2.361
Project delivery method selection	5.8	2.341
Continuous improvement	5.786	2.093
Long term commitment	5.761	2.568
Project type experience	5.721	1.918

Table 9-Continued

Attribute	Scale Value	Standard Deviation
Shared BIM	5.693	2.27
Clear benefits for all	5.675	2.32
Reward structure linked to the success of the project	5.252	2.125
Eliminate multilayer subcontracting structure	5.108	2.66
Category Boundary 6= 4.968		
Less reliance in contracts	4.954	2.909
Open book accounting	4.824	2.575
Use of facilitator	4.245	2.688
One team one location	4.131	2.578
Category Boundary 5= 3.847		
Category Boundary 4= 2.765		
Category Boundary 3= 2.070		
Category Boundary 2= 1.00		
Category Boundary 1= 0.00		

Before utilizing the results, the fit of the model has to be assessed. The first assumption that needs to be checked is whether the discriminal process distributions of the category boundaries and of the attributes are normally distributed, and the second assumption is whether the variance of the discriminal process distribution for category boundaries does not differ among category boundaries. To check these assumptions a plot of the observed probits versus the scale values for each category boundary value is presented in Figure 12. In addition, a plot of the observed probits against the category boundaries for each attribute is presented in Figure 13. A table of the probits calculated for this analysis is presented in Appendix D.

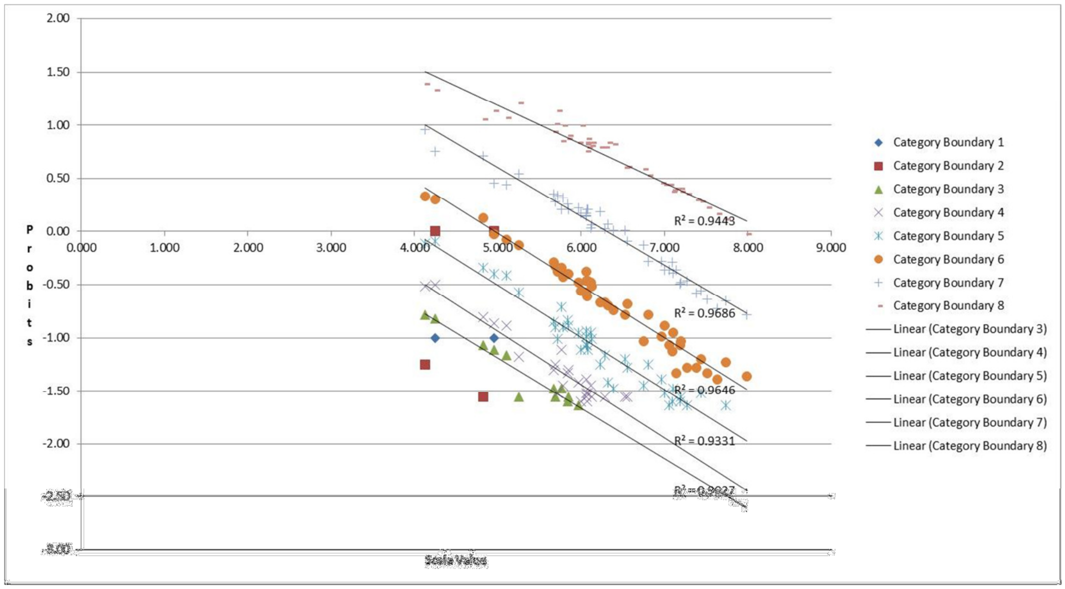

Figure 12- Probits against scale values for each category, analysis run with nine rating categories

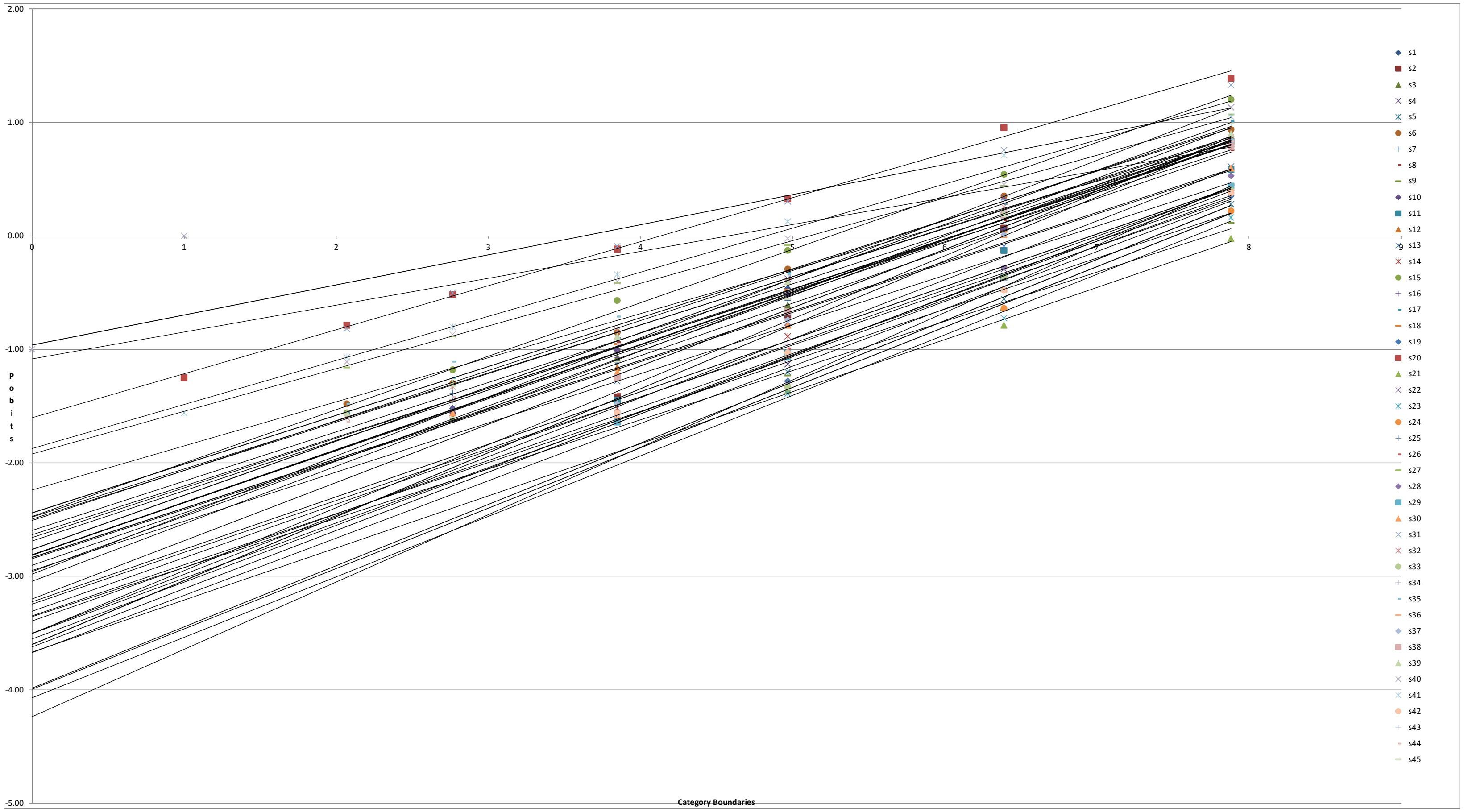

Figure 13- Probits against category boundaries for each IA, analysis run for nine rating categories

In Figure 12, it can be observed that the probits associated with category boundaries 4 and higher fall near straight lines. In Figure 13, it can be observed that the probits fall near straight lines for most IAs, indicating that the normality assumption is met. There are very few points on the first, second and third categories, therefore it is difficult to infer anything about the fit of the model for those categories. On the other hand, in Figure 12 the lines are approximately parallel indicating that the variance of discriminal process distribution of category boundaries is relatively constant across them. Moreover in Figure 13 it can be observed that the lines are crossing and are not parallel indicating that the discriminal process variance varies among IAs. All of the above indicate that the model selected is appropriate for the data in the higher categories.

From the figures above and due to the absence of scale values below the fifth, category boundary it is clear that respondents did not rate any attribute as not important to achieve integration. This result was expected as all the attributes under study were identified in literature as important for project integration.

Thurstone's Successive Interval Procedure for Six Rating Categories

Considering that the rating categories 1-4, indicate that the perception of the respondent is such that the IA is not important to achieve project integration, and that the cumulative proportions for all but eight IAs, is less than 10% in the fourth category (the cumulative proportions are found in Appendix D); it was decided to collapse rating categories 1, 2, 3 and 4. Thus, in the recoded data, the first rating category refers to anything that is not important, the second category refers to anything that is neutral, and the higher order rating categories refer to different degrees of importance. The model was run again using these six rating categories.

The category boundaries for the analysis performed with six rating categories are presented in Table 10 and a graphical representation of the category boundaries is shown in Figure 14, the scale values and the standard deviation for each attribute and the category boundaries are presented in

Table 11. The complete results of this analysis are shown in Appendix E.

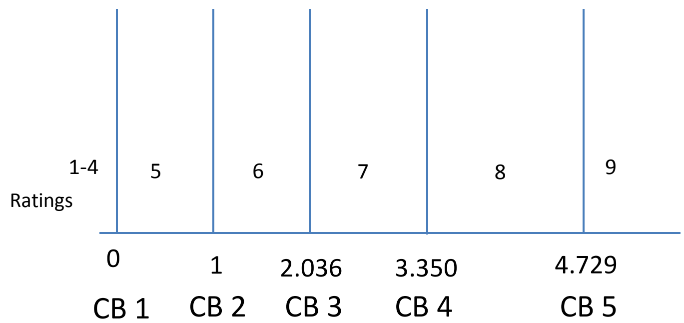

Figure 14- Graphical representation of the category boundaries, analysis performed with six rating categories

Table 10- Category boundaries, analysis performed with six rating categories

Category Boundary	1	2	3	4	5
Category boundary Value	0	1	2.036	3.350	4.729

Table 11- Scale values and standard deviations for each IA, analysis performed with six rating categories

Attribute	**Scale Value**	**Standard Deviation**
Open and continuous communication	4.828	2.014
Category Boundary 5= 4.729		
Early involvement of key project participants	4.593	2.132
Project manager leadership	4.501	1.736
Information share and exchange	4.384	1.736
Trust	4.317	2.051
Timely responsiveness	4.269	1.716
Owner commitment	4.165	1.83
Personal attitude and commitment	4.098	1.962
Efficient coordination	4.085	1.895
Adequate resources	4.043	1.557
Top management support	4.010	2.018

Table 11-Continued

Attribute	Scale Value	Standard Deviation
Atmosphere of mutual respect	4.000	1.845
Clear responsibilities and accountability structure	3.964	1.799
Early goal definition	3.919	1.956
Knowledge share	3.881	1.998
Common goals and objectives	3.731	2.13
Team selection criteria	3.679	1.778
Intensified planning	3.501	2.132
Contracting structure that fosters collaboration	3.474	2.128
Category Boundary 4=3.350		
Understanding other needs and expectations	3.350	1.636
Internal conflict and dispute resolution	3.283	1.666
Collaborative decision making	3.253	2.003
Subcontractor involvement	3.204	1.799
Team building and teamwork	3.107	2.017
Intensive involvement of a knowledgeable owner	3.101	2.146
Adequate risk management	3.061	1.993
Performance oriented culture	3.059	1.899
Training and education	3.048	2.108
Appropriate use of technology	3.048	1.993
Innovation and innovative thinking	3.047	2.083
Team experience	2.988	1.822
Member's Company culture	2.969	2.077
Facility manager involvement	2.856	2.141
Project delivery method selection	2.844	2.152
Continuous improvement	2.792	1.934
Long term commitment	2.759	2.428
Project type experience	2.732	1.773
Shared BIM	2.714	2.064
Clear benefits for all	2.704	2.081
Reward structure linked to the success of the project	2.276	2.013
Eliminate multilayer subcontracting structure	2.159	2.475
Less reliance in contracts	2.081	2.428
Category Boundary 3= 2.036		
Open book accounting	1.850	2.499
Use of facilitator	1.284	2.616
One team one location	1.234	2.425
Category Boundary 2= 1.000		
Category Boundary 1= 0.000		

In order to check if the output of the model changed when collapsing rating categories 1, 2, 3 and 4 into a single category, a Pearson correlation between the scale values of the IAs derived with nine categories and the scale values of the IAs derived with six categories was run. The correlation value obtained was 0.9998. This result indicates that the scale values were a linear transformation of each other. In addition the location of the scale values in reference to the category boundaries did not change notably. Two main changes in this regard are found; the first one is in IA "less reliance in contracts", which analyzing nine categories falls below category boundary six (between ratings 6 and 7), while in the analysis of six categories falls right above the third category boundary (between ratings 7 and 8). The second one is in IA "understanding other's needs, expectations, and disciplines" that in the analysis of nine categories falls right below category boundary 7 (between ratings 7 and 8), while in the analysis of six rating categories, its scale value corresponds to the same value of category boundary 4 (between 7 and 8).

In addition the fit of the model was checked using the plot of the probits against the scale values for each category boundary (Figure 15) and the plot of the probits against the category boundaries for each IA (Figure 16) for the six rating category analysis.

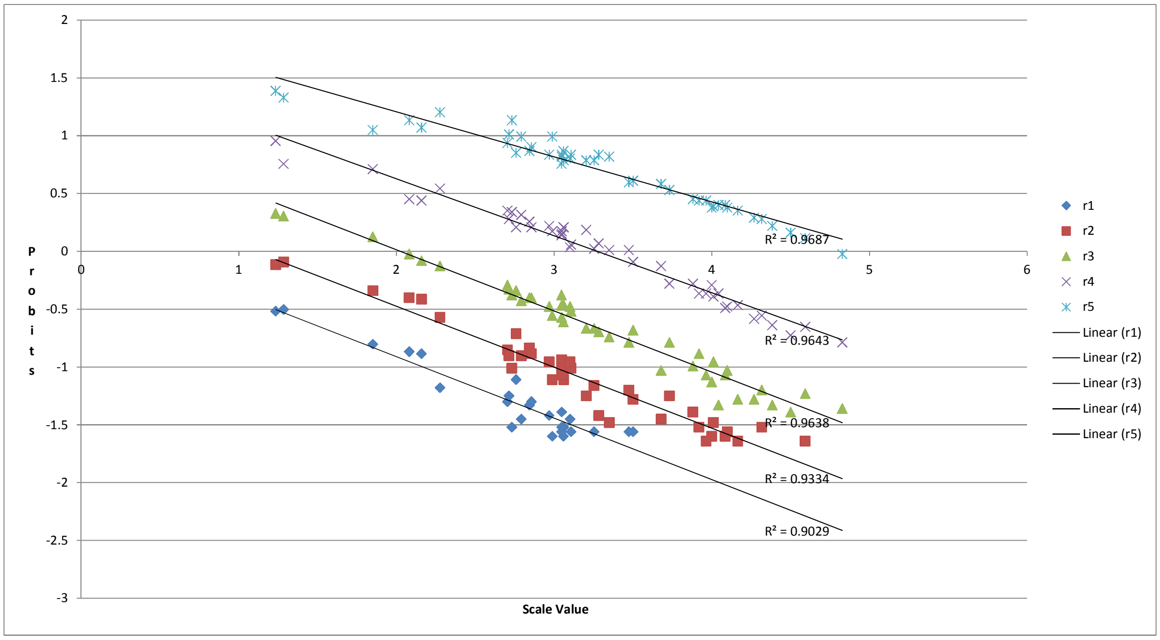

Figure 15- Probits against scale values for each category, analysis performed with six rating categories

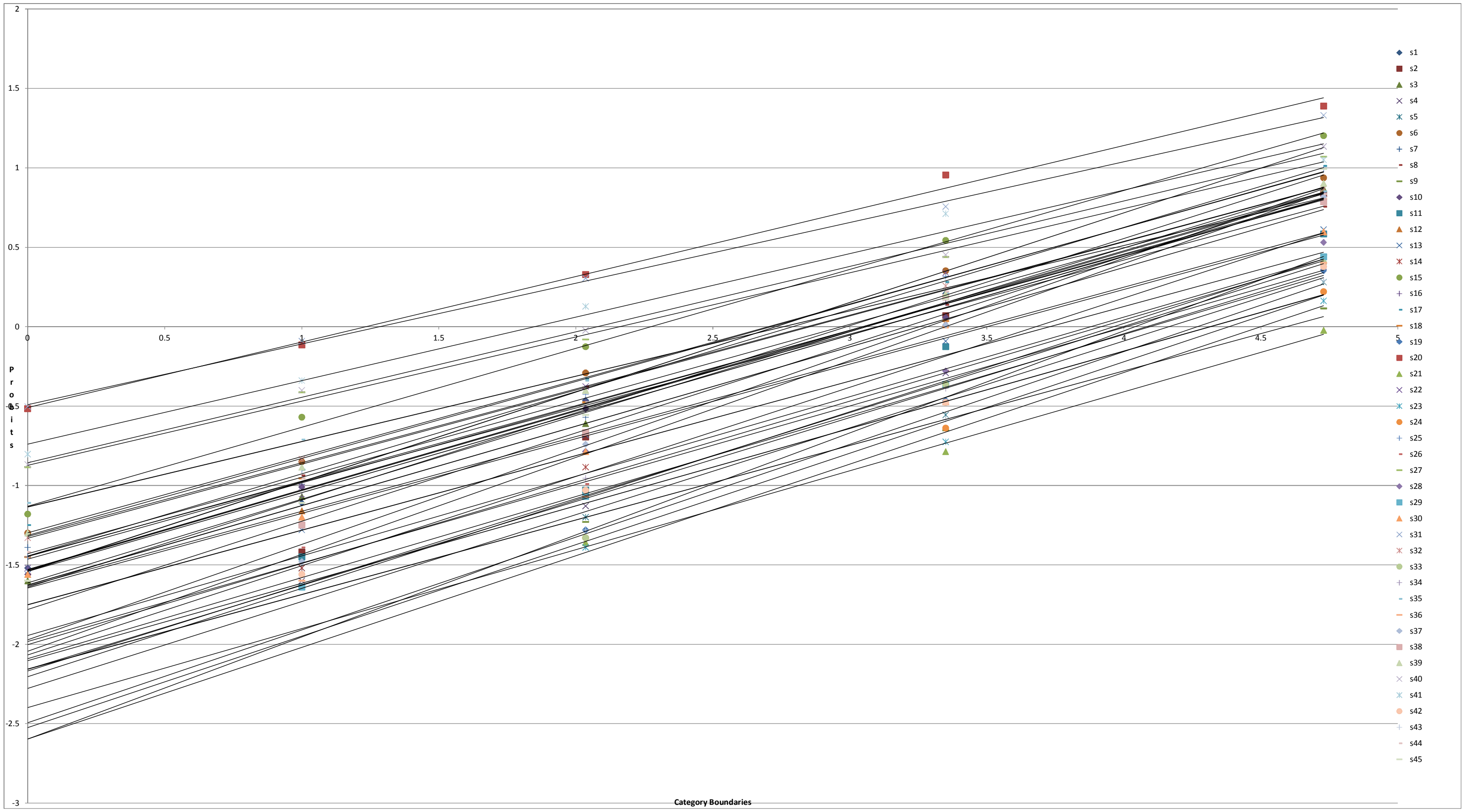

Figure 16- Probits against category boundaries for each scale value, analysis performed with six rating categories

In Figure 15 it can be observed that the points fall very near the regression lines even in the lower categories. In addition the lines are approximately parallel. This is because in this analysis there are more ratings in the category that combine former rating category 1, 2, 3 and 4. In Figure 16 it is clear that the points also fall near the regression lines and the lines are crossing. All of the above suggest that the assumptions of normality of the discriminal process distributions for the IAs and for the category boundaries, and of the constant variance of the discriminal process distributions among category boundaries hold. In addition the variance of the discriminal process distribution is not constant among IAs as lines are crossing in Figure 16.

One of the main objectives of this study is to identify the critical success attributes for achieving project integration (CSIAs). These are the attributes that are very important for achieving integration; their identification helps to have a comprehensive understanding of the CSIAs at the project level. The criterion used to operationally define which are the CSIAs is the scale value 3.350 that corresponds to category boundary 4, this category boundary is the boundary between ratings 7 and 8; since every IA above this boundary is an IA that most respondents rated 8 or 9. Thus, every IA which scale value is above the criterion of 3.350 is considered a CSIA. A graph of all the IAs and their scale values, highlighting the critical success attributes and the non-critical success attributes, and the category boundaries, for the complete group of respondents is shown in Figure 17.

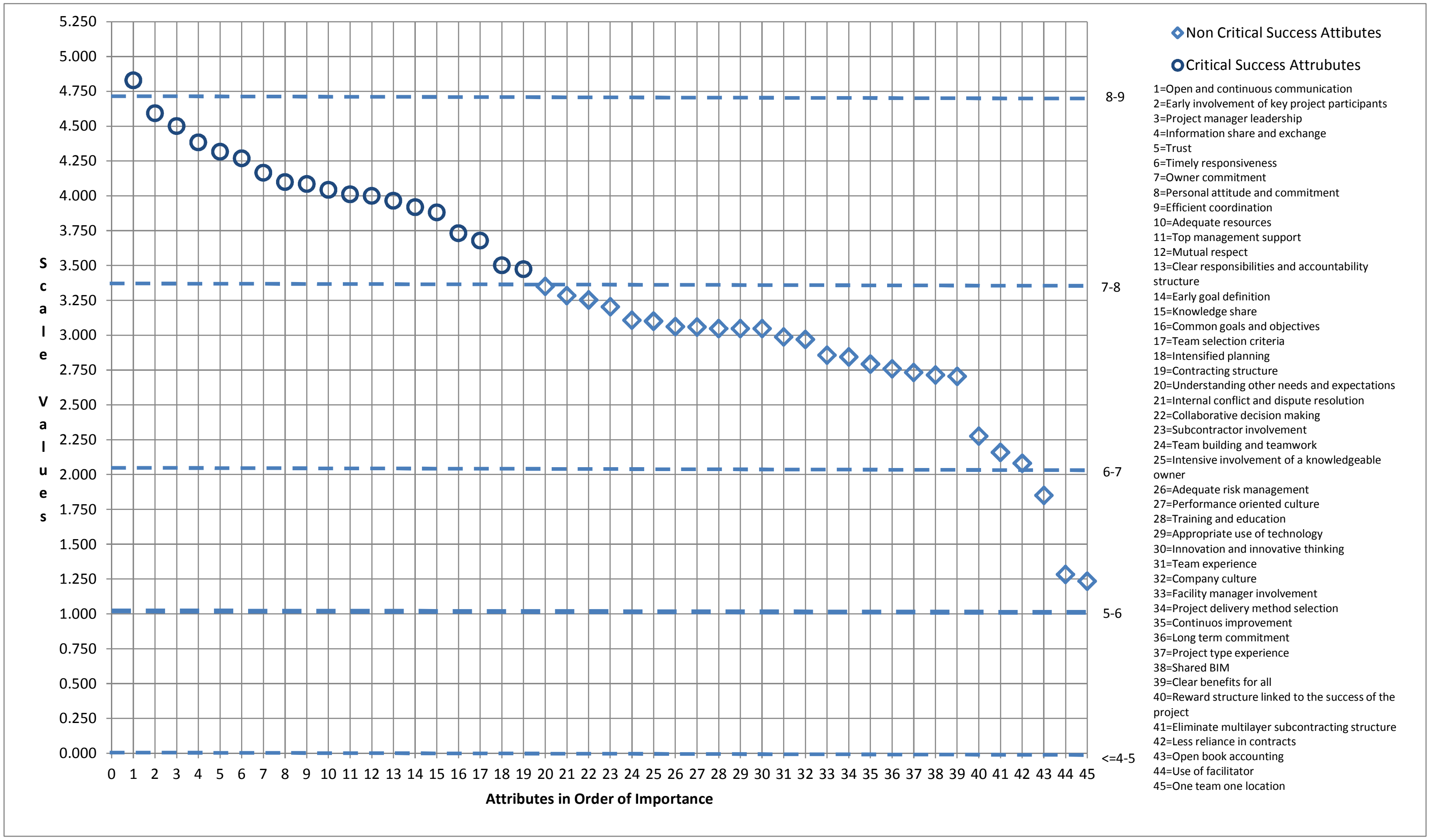

Figure 17- IAs in order of importance to achieve project integration

From this analysis it can be concluded that the respondents think that all of the IAs under study have some level of importance for achieving project integration, as none of the IAs fall below category boundary 2. This would mean that the IA is not important for project integration or that the IA is neutral for project integration. IA that fall between category boundaries 2-3 are attributes that have some level of importance; however the degree of importance is relatively low.

According to the respondents the IA that has the lowest level of importance is "one team one location", they think that relocating the team to work in a single location is not critical for achieving project integration, this is aligned with the statement of Sun and Aouad (2000), who said that bringing the team to a single location can help to some extent, but it is not practical and many times it is not possible, therefore it is important to have other tools to support team work.

The second lowest level of importance is given to the IA "use of facilitator"; this result is very similar to the result found by Kumaraswamy et al. (2005) in their research. They found that having a full time external facilitator is not a requirement to build an integrated team.

The third IA that fell below category boundary three is "open book accounting"; the perception of respondents is that having in place a financial structure where all expenses and costs are explicit to all team members is not essential for project integration.

Even though the three IAs described above fall under category boundary 3, IAs "one team one location" and "use of facilitator" fall very close to the category boundary 2 as can be observed in Figure 17, while IA " open book accounting" falls very close to the third category boundary. This indicates that the first two IAs might be somewhat neutral for project integration, while the third IA might be important in a low level of importance.

The IAs that fall between category boundary 3 (2.036) and category boundary 4 (3.350) are IAs, considered to have a medium level of importance for achieving project integration. Respondents think that these IAs, although can help in the integration process of a project are not considered essential for achieving project integration. There are 23 IAs that fall in this range.

The IAs located above the 4th category boundary are the IAs respondents rated as having a very high level of importance for achieving project integration and were mostly rated as 8 or 9 in the rating scale. Therefore, for the purpose of this study, those IAs are considered the CSIAs. There are 18 IAs that fall between category boundary 4 (3.350) and category boundary 5 (4.729) and one IA that falls above category boundary 5 (4.729). Therefore according to respondents the single most important IA for achieving project integration is "open and continuous communication" defined for the purpose of this study as maintaining open and direct lines of communication between all project participants at all times, with no restrictions because of roles within the team.

Correlation Analysis

In order to confirm the results obtained using the Thurstone Scaling Method, three other analyses were performed. First a correlation analysis between the scale values and the mean of each IAs; second a factor analysis to determine the number of dominant dimensions of the importance ratings for project integration; and third a cluster analysis, to see how the IAs are clustered.

The correlation analysis was developed using a Pearson correlation and a Spearman rank order correlation. The value of the Pearson correlation between the scale values and the mean of the ratings for each IA is 0.992 and the Spearman rank order correlation value between the same variables is 0.959. These results indicate that the scale values are a good representation of the ratings of the importance of each of the IAs for achieving project integration.

Factor Analysis

The ratings obtained for each IA were factor analyzed, to determine the number of dimensions of the importance ratings. In order to conduct the factor analysis the first step was to develop a bootstrapped of parallel analysis to determine the number of factors to keep. In Figure 18, it can be observed that the number of dimensions where the eigenvalues of the actual data and the eigenvalues of the bootstrapped data cross is two, indicating that there are mainly two dimension of importance for project integration. For the complete output of the bootstrapped of parallel analysis please refer to Appendix F.

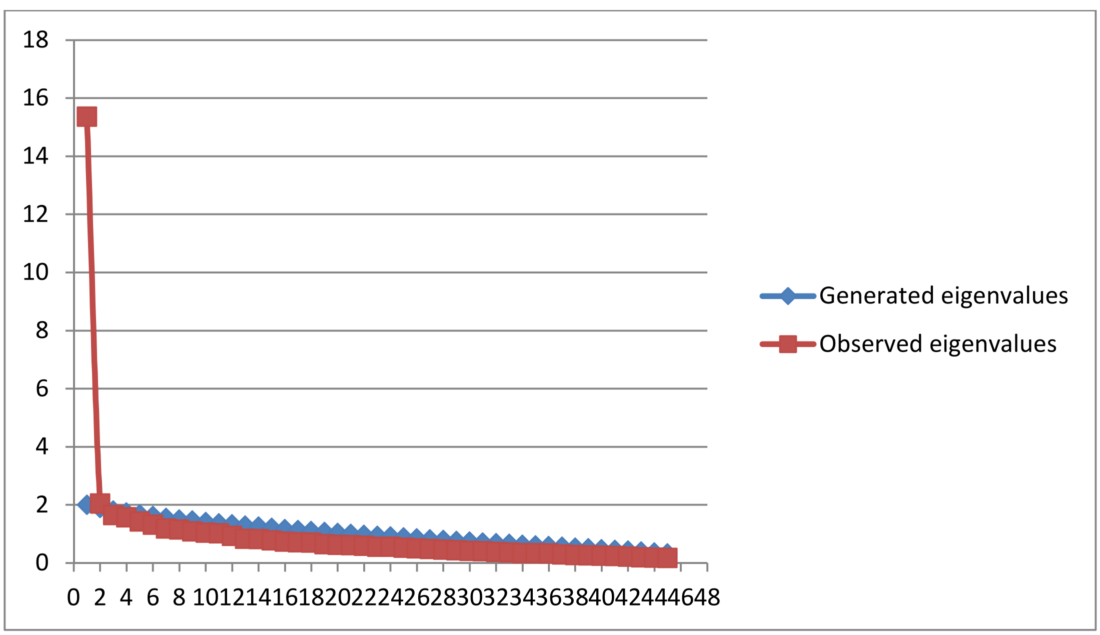

Figure 18- Result of Bootstrapped of Parallel Analysis

Taking into consideration the result of two factors to retain of the bootstrapped of parallel analysis, a factor analysis was performed for two factors. The complete results of the factor analysis can be found in Appendix G. Table 12 shows the eigenvalues of the first two factors and the variance explained by the model.

Table 12- Total variance explained by the factor model with two factors

Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings[a]
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	15.358	34.129	34.129	14.745	32.766	32.766	13.448
2	2.047	4.549	38.678	1.414	3.143	35.909	12.888

From Table 12 it can be observed that the dominant factor of the model accounts for 32.766% of the variance, while the second factor accounts for a very marginal portion of the variance, and the total variance explained by the model is below 40%. Indicating that the data is mainly unidimensional and that a model based on linear combinations, as is the factor analysis, is probably not the best representation of the perception of respondents. In addition the correlation of the two factors is 0.765 suggesting that possibly there is just one single factor and that the importance of the different attributes to achieve project integration is unidimensional. Therefore loadings of the dominant factor for the two-factor rotated solution are analyzed. Table 13 shows the values of the loadings of the dominant factor for the rotated solution.

Table 13- Loadings of the rotated solution for the dominant factor

Attributes	Pattern Matrix
Adequate resources	0.839
Timely responsiveness	0.721
Open and continuous communication	0.689
Clear responsibilities and accountability structure	0.689
Early goal definition	0.652
Early involvement of key project participants	0.626
Intensified planning	0.620
Performance oriented culture	0.619
Understanding other’s needs, expectations and disciplines	0.602
Efficient coordination	0.591
Team selection criteria	0.587
Organization and project manager leadership	0.533
Internal conflict and dispute resolution	0.531
Common goals and objectives	0.511
Team experience	0.499
Information share and exchange	0.492
Trust	0.461
Training and education	0.420
Innovation and innovative thinking	0.410
Contracting structure that fosters collaboration	0.390
Subcontractor involvement	0.382
Clear benefits for all	0.351
Project type experience	0.350
Knowledge share	0.315
Appropriate use of technology	0.291
Adequate risk management	0.281
Top management support	0.266
Atmosphere of mutual respect	0.259
Owner commitment	0.239
Personal attitude and commitment	0.211
Project delivery method selection	0.148
Team building and teamwork	0.134
Continuous improvement	0.126
Reward structure linked to the success of the project	0.079
Member’s company culture	0.077
Facility manager involvement	0.006
One team one location	0.005
Collaborative decision making	-0.019
Long term commitment	-0.021
Use of facilitator	-0.036
Intensive involvement of a knowledgeable owner	-0.044
Shared BIM	-0.088
Eliminate multilayer subcontracting structure	-0.092
Less reliance in contracts	-0.095
Open book accounting	-0.235

The dominant rotated factor is a good representation of the perception of respondents regarding the importance of the different IA to achieve project integration because the Pearson correlation between the loadings of this factor and the scale values is 0.712. This is not a very high correlation as the one obtained for the scale values and the means; however it is an acceptable value. This indicates that the results of the Thurstone Scaling Method analysis and of the factor analysis are similar. However, the orientation or direction of the factor matters and it is necessary to have a rotated solution. In addition, it confirms that the responses are pretty much unidimensional.

From Table 13 it can be observed that IAs that are in the upper portion of the scale are the same IAs that have higher loading; even though the order is not the same, there are similarities to a large extent. The IAs that were located in the scaling procedure below the third category boundary (2.036) and the ones that were located very close to that category boundary, have very low loadings, while the IAs that were located above the fourth category boundary (3.350) or very close to it are to a large extent the same IAs that had a loading of more than 0.4. There are some exceptions to this rule, but for the most part the results are similar. One of the reasons for this is that the Thurstone Scaling Method is a one-dimensional method; however it is not a linear method. The Thurstone Scaling Method fits the data very well, while the variance explained by the factor analysis is not very high, therefore for the purpose of selecting CSIAs the results of the Thurstone Scaling Method is used. The high correlation between the first and second factors suggests that the perception of importance of the respondents is unidimensional.

Cluster Analysis

The third analysis performed to elucidate the results of the Thurstone Scaling Method is a cluster analysis. The cluster analysis helps to illustrate the similarity of IAs with respect to the importance ratings across the 218 respondents who responded completely Part 1 of the survey. The complete result of the cluster analysis is shown in Appendix H.

In order to determine the number of clusters, it is necessary to interpret three statistics from the cluster history table: the cubic clustering criterion, the pseudo-F and the pseudo-t^2. According to the cubic clustering criterion the data is skewed, however it is not possible to determine the number of clusters. The pseudo-F statistic suggested two clusters as there was a peak on the second cluster. The pseudo-t2 suggested that there were two clusters as well. Therefore the IAs are grouped in two clusters based on the behavior of IAs ratings across all the respondents. The IAs that fell in each of the clusters can be observed in Figure 19.

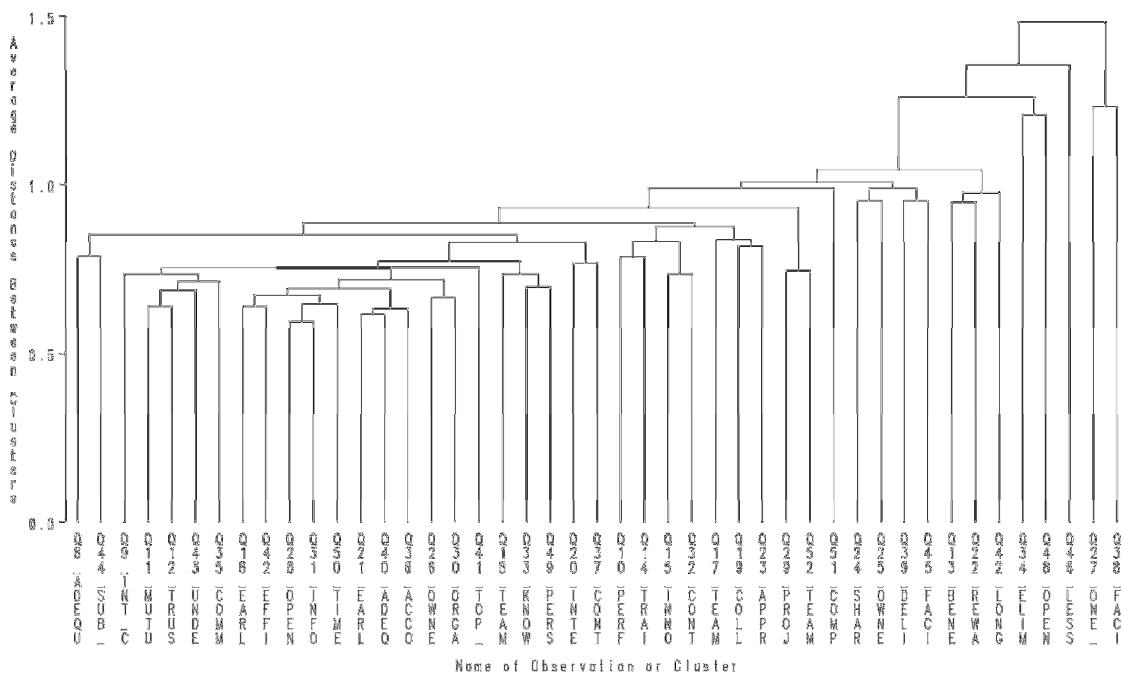

Figure 19- Dendrogram of the 45 IAs clustered across all the respondents

According to the dendrogram in Figure 19, cluster one includes all but two 45 IAs. The two IAs that compose the second cluster are “use of facilitator” and “one team one location”. This indicates that the IAs were rated in a similar fashion across all the respondents; however the respondents rated differently those two IAs. When comparing these results with the results obtained with the Thurstone Scaling Method, these two IAs are the ones that have the two lowest scale values. Furthermore, there is a jump between these two IAs and the third IA on the Thurstone scale. This result could suggest that these two IAs could be the only ones that may not have any level of importance for achieving project integration and that they are very close to be neutral for achieving project integration.

Differences and Similarities on Critical Success Attributes and on the Importance of Other Integration Attributes Depending on Industry Role

In order to determine if there are major differences and similarities on the critical success attributes for project integration (CSIAs) and on the importance of other integration attributes (IA) depending on the role of the respondent in the industry, two main analyses were developed. First Thurstone Scaling Method was used to develop one scale for each role, to determine the critical success attributes and the importance of each IA for each one, and second analysis of variance (ANOVA) was used to identify mean differences on the different IAs.

Thurstone's Successive Interval Procedure by Industry Role

In order to use the successive interval procedure the data was collapsed using the same six rating categories used for the complete data set. Thus the original category ratings 1, 2, 3, and 4 were collapsed into a single category; therefore every category reflecting some level of unimportance for achieving project integration was collapsed into a single category. In addition, some roles were collapsed as well, and the respondents who were classified as other were excluded from this analysis. Originally the roles extracted from the survey were owner, architect, engineer or specialty consultant, general contractor, subcontractor or supplier, and facility manager. The number of responses obtained for subcontractors or suppliers and for facility managers was small (10 for subcontractors and 7 for facility managers when deleting all the responses from people who had any missing data). Therefore each of these groups was collapsed with the respondent groups that were more aligned with their role in the project. Therefore, facility managers were collapsed with owners, forming a new group called owner + facility manager, and subcontractors or suppliers were collapsed with general contractors, forming a group called general contractor + subs.

The CATJUG program (Roberts, 2010) was used to construct the scale for each of the four role categories using the six rating categories data.

Owners + Facility Managers

The category boundaries for the group owner + facility manager (N=34) are presented in Table 14. The scale values and the standard deviation of the discriminal process distribution for each attribute in order of importance are presented in Table 15. The complete results of the scaling procedure for owners and facility managers are presented in Appendix I.

Table 14- Category boundaries for owners + facility managers

Category Boundary	1	2	3	4	5
Category boundary Value	0	1	1.905	3.012	4.211

Table 15- Scale values and standard deviations for each IA for owners + facility managers

Owners + Facility Managers		
Attribute	**Scale Value**	**Standard Deviation**
Clear responsibilities and accountability structure	4.290	2.519
Early involvement of key project participants	4.269	2.193
Category Boundary 5= 4.211		
Open and continuous communication	4.187	1.933
Atmosphere of mutual respect	4.124	1.478
Owner commitment	4.112	1.340
Organization and project manager leadership	4.046	1.344
Information share and exchange	4.010	1.626
Top management support	3.755	1.241
Knowledge share	3.719	2.150
Timely responsiveness	3.675	1.397
Efficient coordination	3.648	1.651
Intensive involvement of a knowledgeable owner	3.645	2.283
Trust	3.611	1.651
Adequate resources	3.600	1.581
Personal attitude and commitment	3.549	1.953
Facility manager involvement	3.494	2.294
Common goals and objectives	3.395	1.607
Intensified planning	3.357	1.871
Early goal definition	3.354	1.676
Performance oriented culture	3.338	1.632
Contracting structure that fosters collaboration	3.320	1.942
Subcontractor involvement	3.183	1.152
Internal conflict and dispute resolution	3.123	1.318
Understanding other needs, expectations, and disciplines	3.059	1.285
Innovation and innovative thinking	3.029	1.893
Category Boundary 4= 3.012		
Member’s company culture	2.998	1.443
Training and education	2.979	2.232
Team selection criteria	2.974	1.839
Adequate risk management	2.947	1.428
Long term commitment	2.924	2.032
Continuous improvement	2.878	1.702
Team building and teamwork	2.871	1.498
Team experience	2.871	1.414
Project type experience	2.777	1.523
Collaborative decision making	2.628	1.760
Clear benefits for all	2.617	1.724

Table 15-Continued

Owners + Facility Managers		
Attribute	**Scale Value**	**Standard Deviation**
Shared BIM	2.389	1.738
Project delivery method selection	2.305	1.445
Reward structure linked to the success of the project	2.151	2.065
One team one location	1.997	1.601
Eliminate multilayer subcontracting structure	1.972	1.936
Open book accounting	1.966	2.427
Category Boundary 3= 1.905		
Use of facilitator	1.845	2.726
Less reliance in contracts	1.731	2.007
Category Boundary 2= 1.000		
Category Boundary 1= 0.000		

The fit of the model was checked using the plots of the probits against the scale values for each category boundary (Figure 20) and the probits against the category boundaries for each integration attribute (IA) (Figure 21) for the analysis of six rating category for the owner + facility manager group.

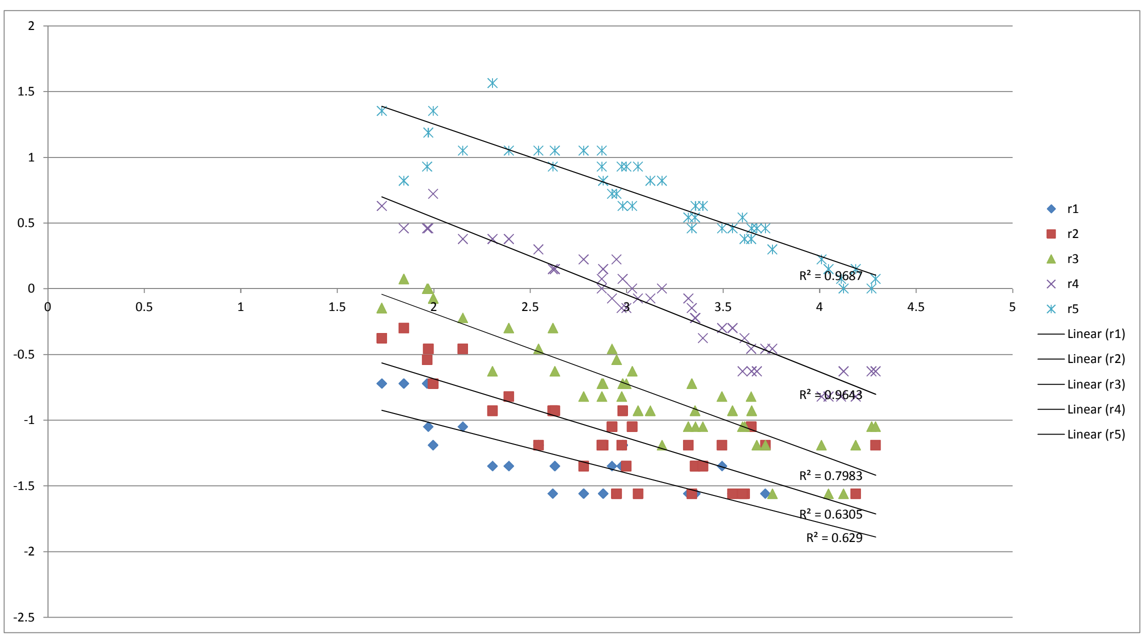

Figure 20- Probits against scale values for each category boundary for owner + facility manager

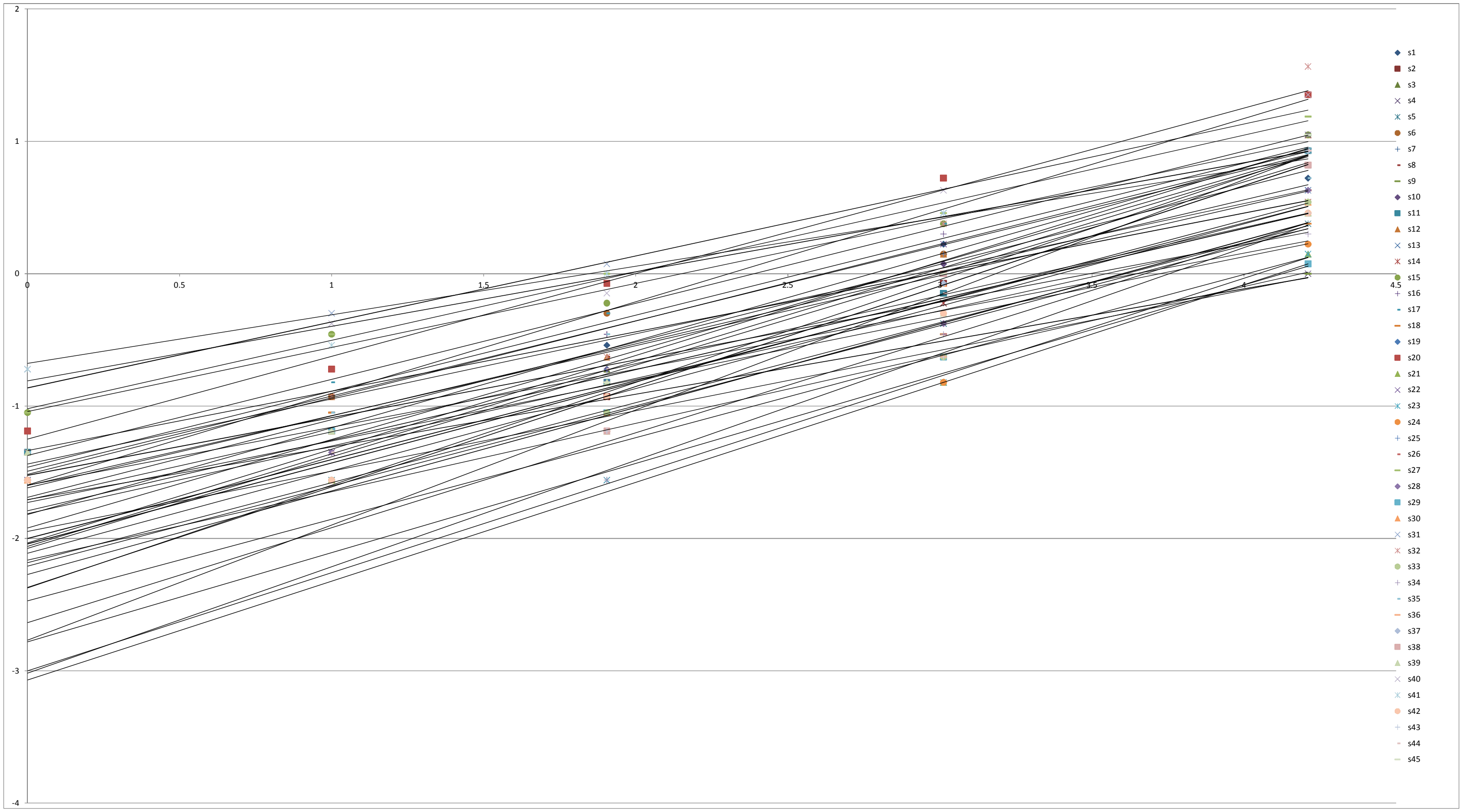

Figure 21- Probits against category boundaries for each IA for owner + facility manager

In Figure 20, it can be observed that the model fits very well the data especially in the higher categories as the values fall very close to the lines and the lines are approximately parallel. It is possible that there are very few responses on the lower categories. In Figure 21 the points also fall near the regression lines, and the lines are crossing. Therefore the assumptions behind the model hold.

In Figure 22 the CSIAs for owners and facility managers and the non-critical success attributes are presented in order of importance according to their scale value are presented. The criterion used to operationally define the CSIAs is the value of the 4th category boundary (3.012), which correspond to the IAs that respondents mostly rated 8 and 9. Category boundaries are presented as well.

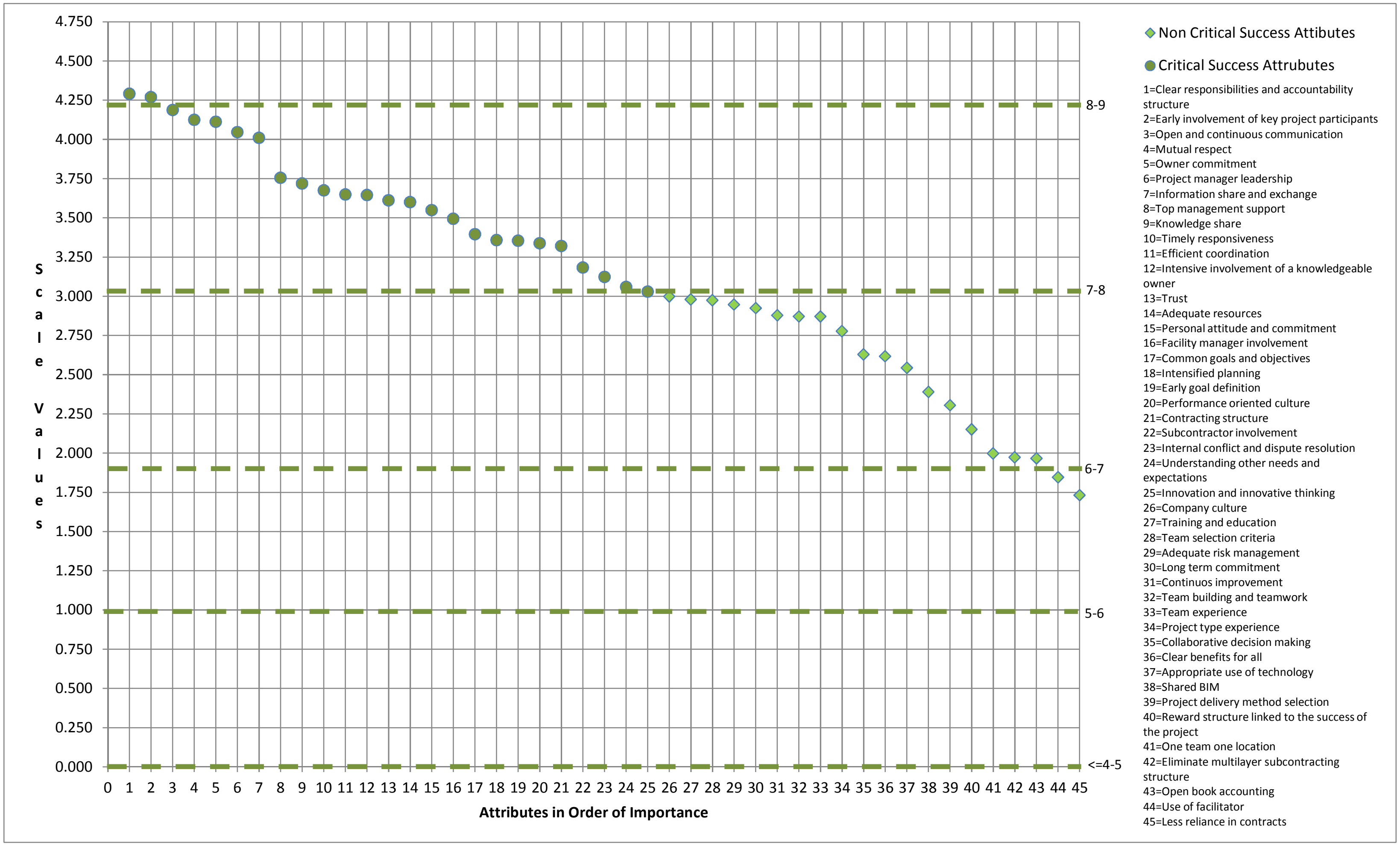

Figure 22- IAs in order of importance to achieve project integration for owners and facility managers

As observed in Figure 22 for owners and facility managers, the IAs fall in an ascending order and for most IAs the difference between two IAs is somewhat constant. For the group of owners and facility managers there are not IAs that fall below category boundary 2 (1.000), therefore their perception is that all the IAs have some level of importance to achieve project integration. There are two IAs that fall below category boundary 3 (1.905) that are “less reliance in contracts” and “use of facilitator”. These IAs have a low level of importance for them; however it is important to point out that these IAs are closer to category boundary 3 than to category boundary 2. There are 18 IAs that fall between category boundary 3 and category boundary 4 (3.013), which have a medium level of importance for owners and facility managers for achieving project integration.

The fourth category boundary for the group of owners and facility manager has a value of 3.013 and is the criterion used to operationally define the CSIA for them. Above this criterion fall all the IAs that respondents mostly rated 8 and 9. There are 23 IAs that fall between category boundary 4 and category boundary 5 (4.211), and there are two IAs that fall above category boundary 5, for a total of 25 CSIA. There are more IAs in between the higher category boundaries for owners and facility manager than for the complete group of respondents, because owners and facility managers used more the upper portion of the rating scale, and did not use much the lower portion of it.

It is important to note that IAs located in the lower portion of the scale are very similar to the IAs located in similar location for the entire group of respondents; however, the exact order is not the same. In addition, most of the IAs that fall around the higher values are the same as the IAs that rated high for the complete group; however the most important IA for owners and facility managers is “clear responsibilities and accountability structure”, which differ from the most important attribute for the complete group, even though it is a CSIA for the complete group as well, and “early involvement of key project participants” is the second IA in order of importance for both groups.

Architects

The CATJUG program (Roberts 2010) was also run for the group of architects (N=51) that responded the survey. The category boundaries for this group are presented in Table 16. The IAs in order of importance, their scale value and standard deviation are presented in Table 17. The complete results of this analysis are presented in Appendix J.

Table 16- Category boundaries for architects

Category Boundary	1	2	3	4	5
Category boundary Value	0	1	2.096	3.293	4.406

Table 17- Scale values and standard deviation for each IA for architects

Architects		
Attribute	**Scale Value**	**Standard Deviation**
Open and continuous communication	4.662	1.267
Early involvement of key project participants	4.454	1.488
Category Boundary 5 = 4.406		
Trust	4.393	1.442
Information share and exchange	4.353	1.066
Efficient coordination	4.224	1.206
Top management support	4.171	2.058
Timely responsiveness	4.169	1.927
Organization and project manager leadership	4.131	1.844
Personal attitude and commitment	4.106	1.509
Atmosphere of mutual respect	3.999	1.241
Knowledge share	3.978	1.673
Adequate resources	3.951	1.239
Clear responsibilities and accountability structure	3.903	1.559
Common goals and objectives	3.873	1.861

Table 17-Continued

Architects		
Attribute	**Scale Value**	**Standard Deviation**
Shared BIM	3.729	2.23
Team building and teamwork	3.705	2.394
Early goal definition	3.705	1.924
Contracting structure that fosters collaboration	3.671	1.923
Collaborative decision making	3.669	2.567
Internal conflict and dispute resolution	3.539	1.938
Intensified planning	3.534	1.947
Team selection criteria	3.495	1.385
Innovation and innovative thinking	3.438	2.023
Performance oriented culture	3.434	1.619
Appropriate use of technology	3.381	1.587
Understanding other needs, expectations, and disciplines	3.361	1.104
Training and education	3.318	1.688
Intensive involvement of a knowledgeable owner	3.296	1.794
Category Boundary 4 = 3.293		
Member's company culture	3.03	2.183
Adequate risk management	2.987	1.904
Project delivery method selection	2.978	1.912
Long term commitment	2.92	2.521
Team experience	2.869	1.591
Continuous improvement	2.868	1.791
Clear benefits for all	2.818	1.99
Subcontractor involvement	2.723	1.716
Facility manager involvement	2.55	1.727
Reward structure linked to the success of the project	2.5	1.785
Eliminate multilayer subcontracting structure	2.398	2.251
Open book accounting	2.397	2.337
Project type experience	2.258	1.738
Less reliance in contracts	2.252	2.382
Category Boundary 3 = 2.096		
Use of facilitator	1.364	2.652
Category Boundary 2 = 1.000		
One team one location	0.905	2.509
Category Boundary 1 = 0.000		

To check the fit of the model a plot of the probits against the scale values for each category boundary and a plot of the probits against the category boundaries for each IA for the six rating category analysis for the architect group was done. The plots are presented Figure 23 and Figure 24 respectively.

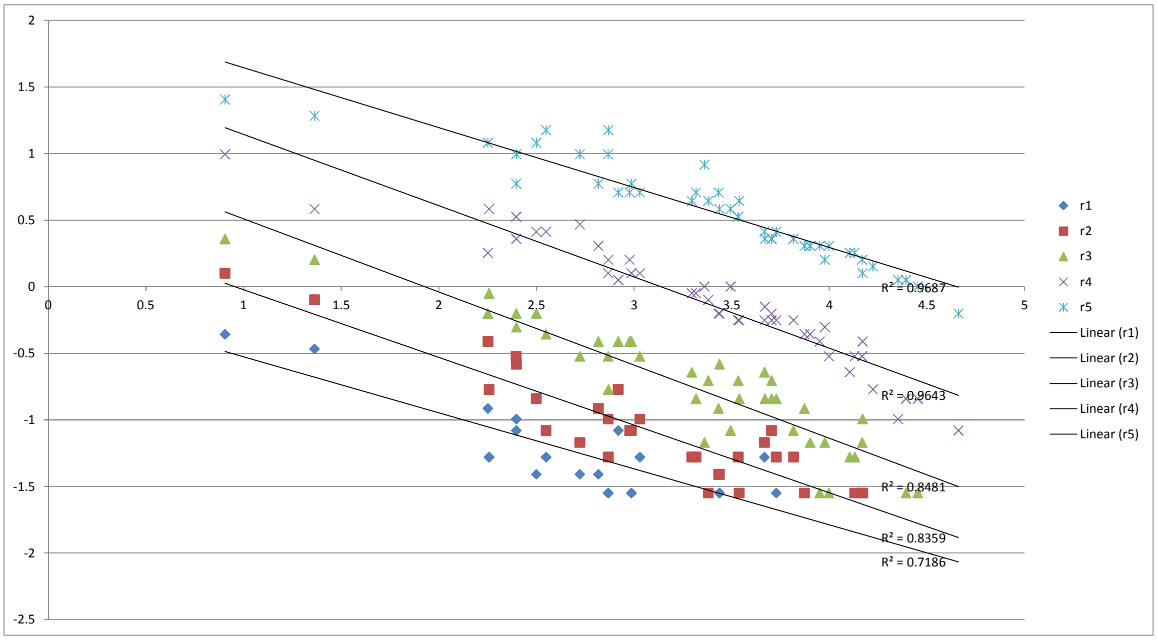

Figure 23- Probits against scale values for each category boundary for architects

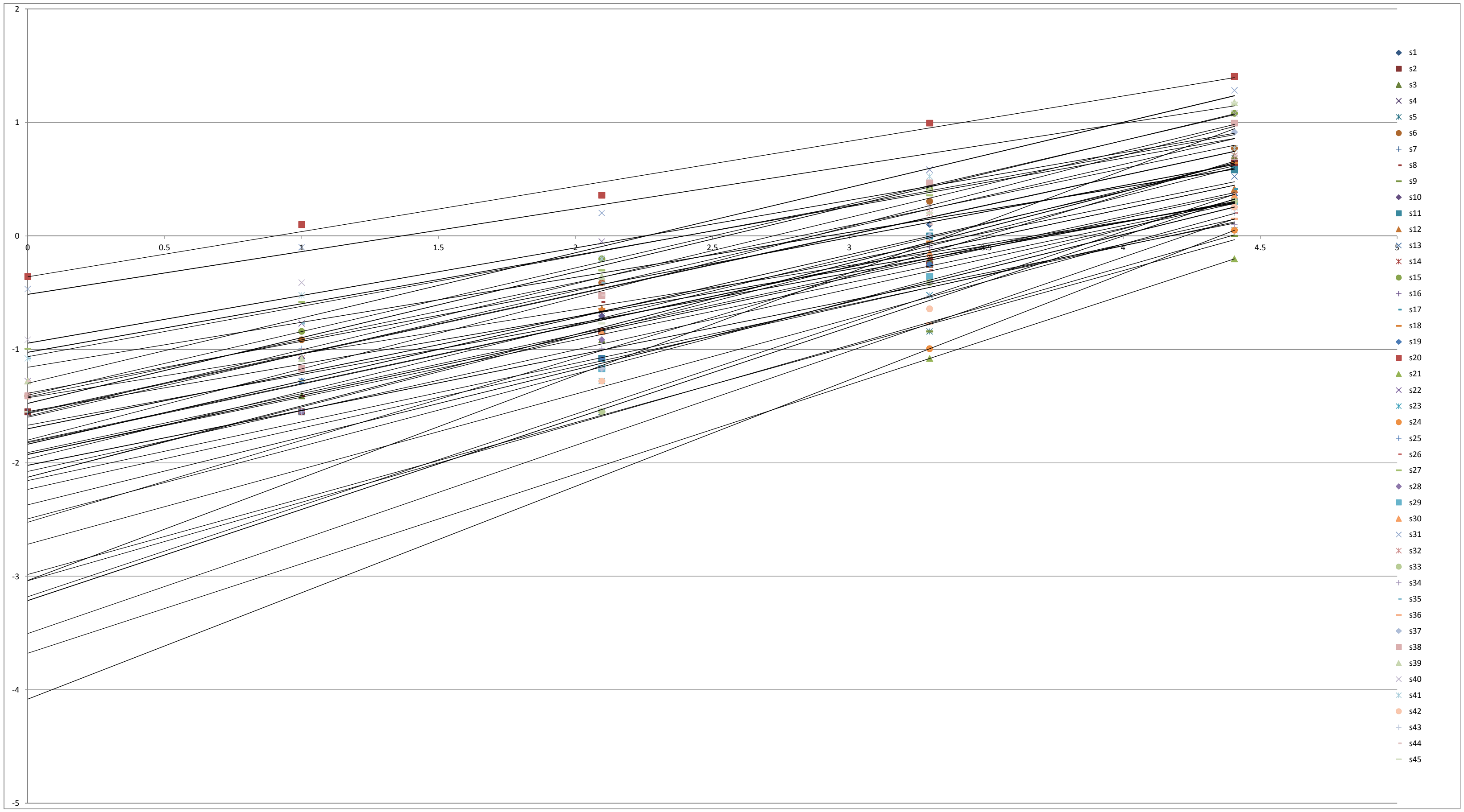

Figure 24- Probits against category boundaries for each IA for architects

The assumptions of the model hold to a large extent as the points fall close to the lines in both plots, and the lines in Figure 23 are approximately parallel especially on the higher categories, and the lines in Figure 24 are crossing. All of the above indicate that this model is a good representation of architects' perceptions.

The IAs and their scale values, and the category boundaries are presented in Figure 25, indicating the order of importance of each IA in order to achieve project integration according to the architects' perception. In addition the figure highlights the attributes that are considered CSIAs by them, and the IAs that are not critical, taking into consideration that the CSIAs are those that have a scale value above the criterion of category boundary 4 (3.293).

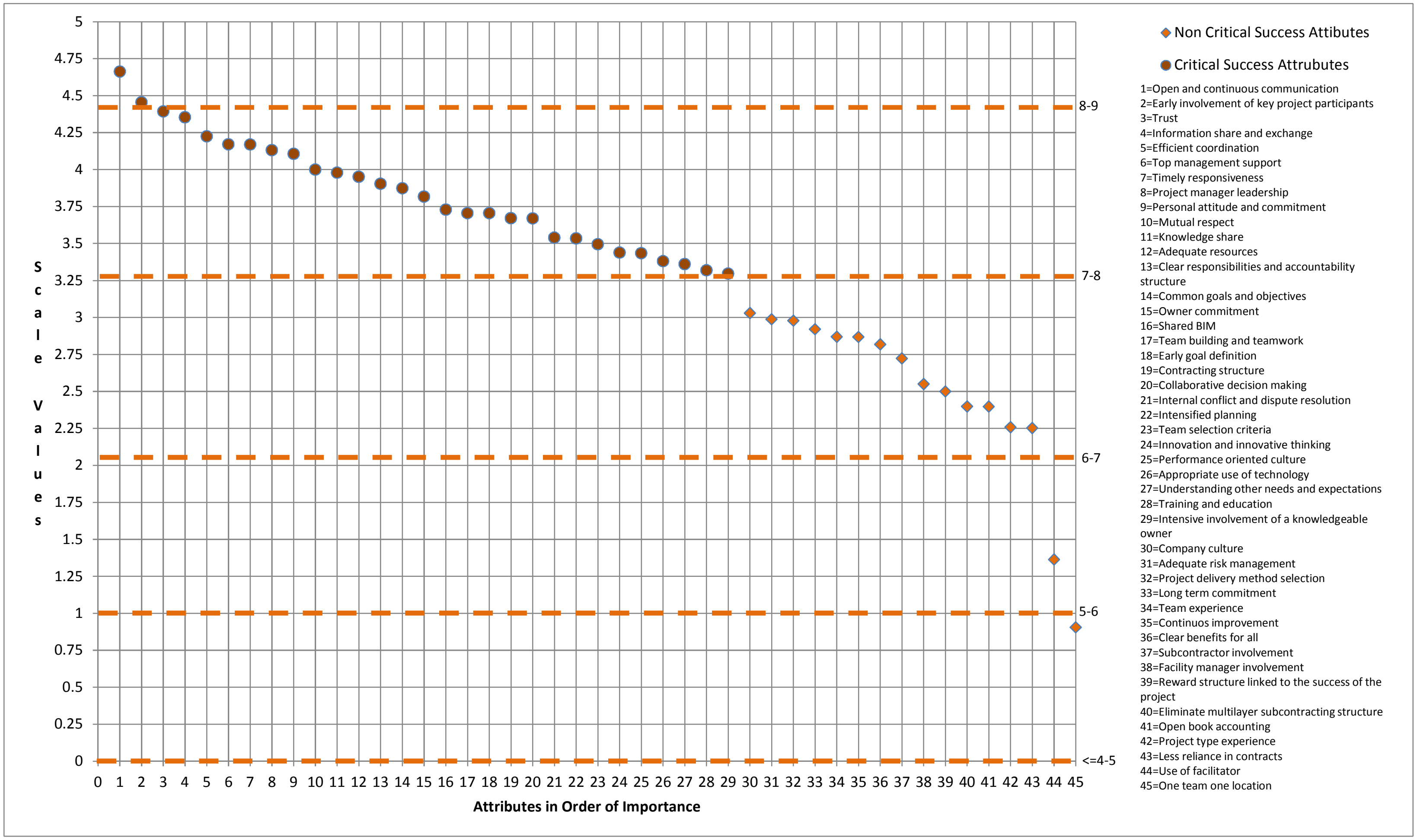

Figure 25- IAs in order of importance to achieve project integration for architects

As seen in Figure 25, for the group of architects the differences for the groups of IAs that fall between category boundaries are more notorious than for the group of owners and facility manager, and for the complete group of respondents. For the group of architects, there is one IA that falls below category boundary 2 (1.000), which is “one team one location”, indicating that this IA is very neutral according to their perception of importance. It is important to point out that for the complete group of respondents and for owners and facility managers none of the IAs fall below category boundary 2. According to architects, there is one IA that falls between category boundary 3 (2.096) and category boundary 2, which is “use of facilitator”. These two IAs are the least important attributes for achieving project integration according to the perception of the complete group of respondents as well.

There are 14 IAs that fall between category boundary 3 and category boundary 4 (3.293), which are IAs considered of medium importance for architects for achieving project integration.

The criterion used to operationally define the CSIAs, as in all the other analyses is category boundary 4, which is category boundary located between 7 and 8 in the rating scale; therefore every IA located above this criterion was mostly rated 8 or 9 by respondent. For the group of architects this criterion has a value of 3.293. There are 27 IAs that fall between category boundary 4 and category boundary 5 (4.406) and there are 2 IAs that fall above category boundary 5, for a total of 29 CSIA.

There are similarities on the IAs located in the upper portion of the scale and in the lower portion of the scale with respect to the complete group of respondents and with respect to the group of owners and facility managers. The two most important IAs for achieving project integration according to the perception of architects are “open and continuous communication” and “early involvement of key project participants”, which are the two most important IAs for the complete group as well. In addition, the two attributes that have the lowest scale value correspond to the same IA with lowest scale values for the complete group of respondents.

It is important to note that the number of CSIA for architects is larger than for the rest of the roles and for the complete group, indicating that they used the upper portion of the rating scale more than the other respondents; therefore they have the perception that more IAs are very important to achieve project integration. However, they also located one attribute below category boundary 2, indicating that they used the lower part of the scale more than other roles; while they used the medium portion of the scale less than other roles.

Engineer or Specialty Consultant

The successive interval procedure was also performed for the group engineer or specialty consultant (N=74). The category boundaries for this group are found in Table 18 and the list of IAs in order of importance, their scale value and their standard deviation are found in Table 19. The complete results of this analysis are shown in Appendix K.

Table 18- Category boundaries for engineers or specialty consultants

Category Boundary	1	2	3	4	5
Category boundary Value	0	1	1.939	3.093	4.260

Table 19- Scale values and standard deviations for each IA for engineers or specialty consultants

Engineers or Specialty Consultants		
Attribute	**Scale Value**	**Standard Deviation**
Organization and project manager leadership	4.337	1.934
Category Boundary 5 = 4.260		
Open and continuous communication	4.093	2.028
Personal attitude and commitment	3.900	1.726
Timely responsiveness	3.855	1.261
Information share and exchange	3.818	1.685
Early involvement of key project participants	3.817	1.990
Owner commitment	3.727	1.702
Trust	3.683	2.062
Adequate resources	3.635	1.252
Early goal definition	3.562	1.639
Efficient coordination	3.535	1.995
Top management support	3.523	1.631
Team selection criteria	3.436	1.837
Clear responsibilities and accountability structure	3.388	1.475
Atmosphere of mutual respect	3.289	1.910
Common goals and objectives	3.201	1.973
Knowledge share	3.178	1.543
Category Boundary 4 = 3.093		
Understanding other’s needs, expectations, and disciplines	3.075	1.704
Collaborative decision making	2.908	1.469
Intensified planning	2.895	1.834
Contracting structure that fosters collaboration	2.770	1.796
Internal conflict and dispute resolution	2.767	1.345
Adequate risk management	2.704	1.937
Subcontractor involvement	2.703	1.663
Project type experience	2.698	1.603
Appropriate use of technology	2.682	1.746
Intensive involvement of a knowledgeable owner	2.640	1.868
Member’s company culture	2.640	1.653
Training and education	2.558	2.021
Performance oriented culture	2.547	1.565
Team experience	2.512	1.719
Team building and teamwork	2.495	1.744
Innovation and innovative thinking	2.486	2.081
Facility manager involvement	2.440	1.942
Continuous improvement	2.370	1.834
Clear benefits for all	2.348	1.866

Table 19-Continued

Engineers or Specialty Consultants		
Attribute	**Scale Value**	**Standard Deviation**
Shared BIM	2.087	1.779
Project delivery method selection	2.031	2.021
Eliminate multilayer subcontracting structure	1.962	2.621
Category Boundary 3 = 1.939		
Reward structure linked to the success of the project	1.928	1.705
Less reliance in contracts	1.587	1.797
Open book accounting	1.193	2.159
Use of facilitator	1.093	2.150
Category Boundary 2 = 1.000		
One team one location	0.619	2.672
Category Boundary 1 = 0.000		

The fit of the model was checked through the plot of the probits against the scale values for each category boundary and through the plot of the probits against the category boundaries for each IA for the analysis of the six rating category for the engineers or specialty consultants. The plots are presented in Figure 26 and in Figure 27 respectively.

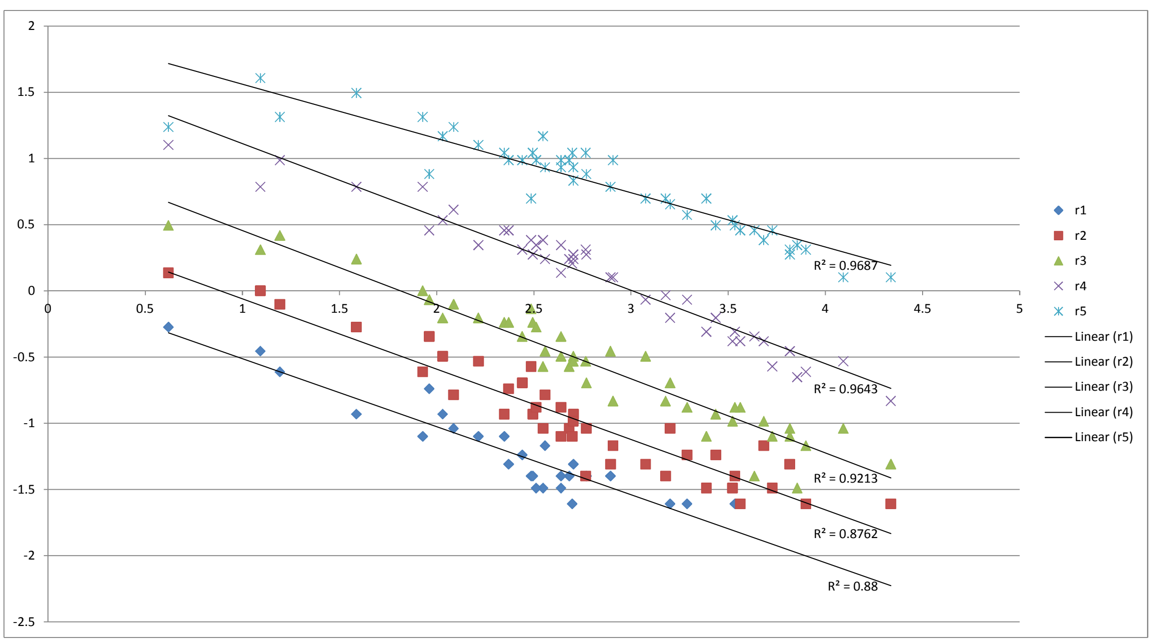

Figure 26- Probits against scale values for each category boundary for engineers or specialty consultants

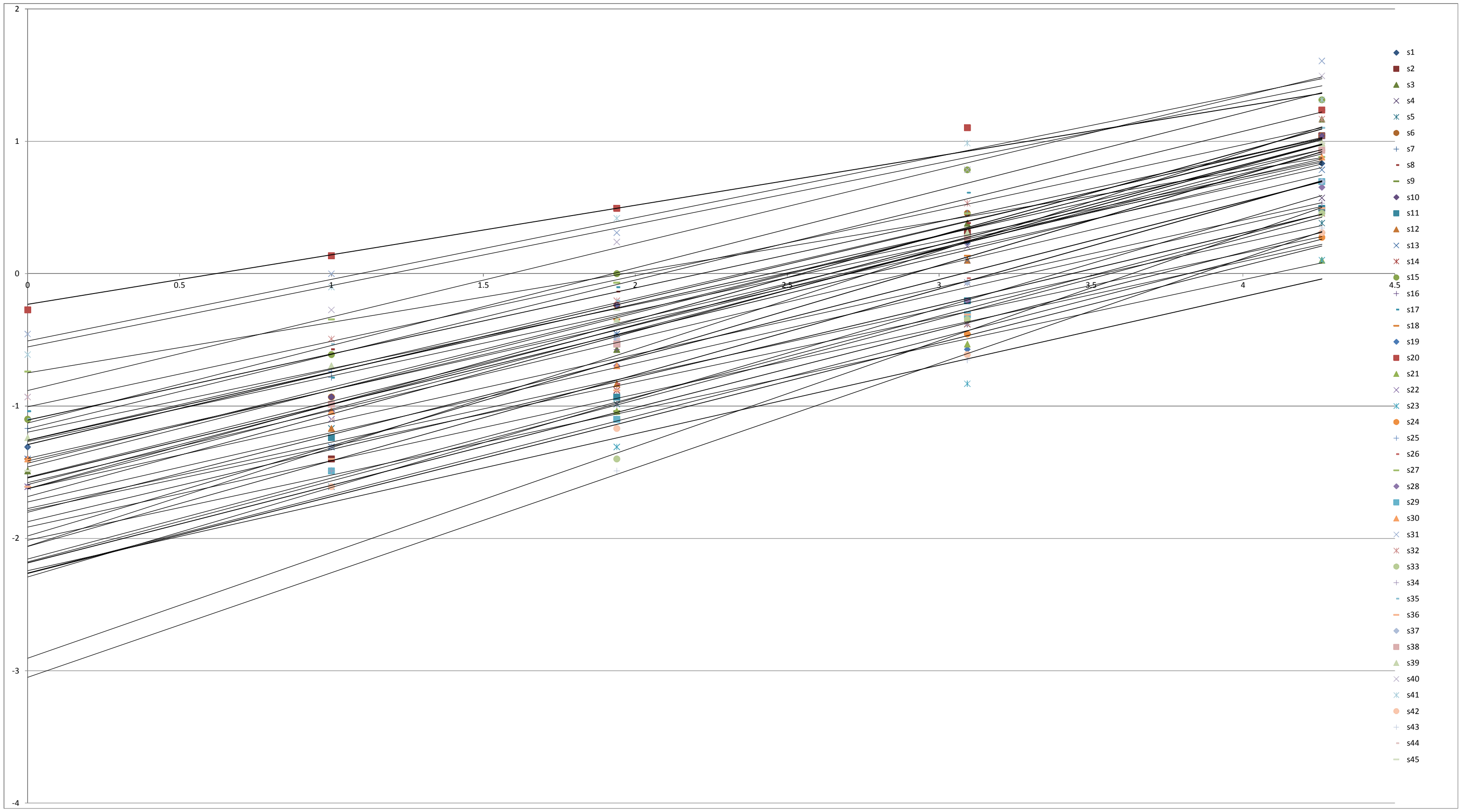

Figure 27- Probits against category boundary for each IA for engineers or specialty consultants

According to Figure 26 and Figure 27 the model is a very good fit of the data even in the lower rating categories because in Figure 26 it can be observed that the points fall very close to the regression lines and the lines are approximately parallel. In addition in Figure 27 the points fall near the regression lines as well and the lines are crossing. One possible reason for the better fit of the model of the data of engineers or specialty consultants compared with the fit of other roles is the number of respondents which is considerably higher.

Figure 28 presents the IAs in order of the importance given by engineers and specialty according to their scale value, and the category boundaries. In addition it differentiates between the CSIA and non-critical success attributes for this specific role. The criterion used to operationally define the SCIA is the value of the category boundary 4 (attributes that respondents mostly rated 8 or 9 on the rating scale), which for engineers and specialty consultants is 3.093.

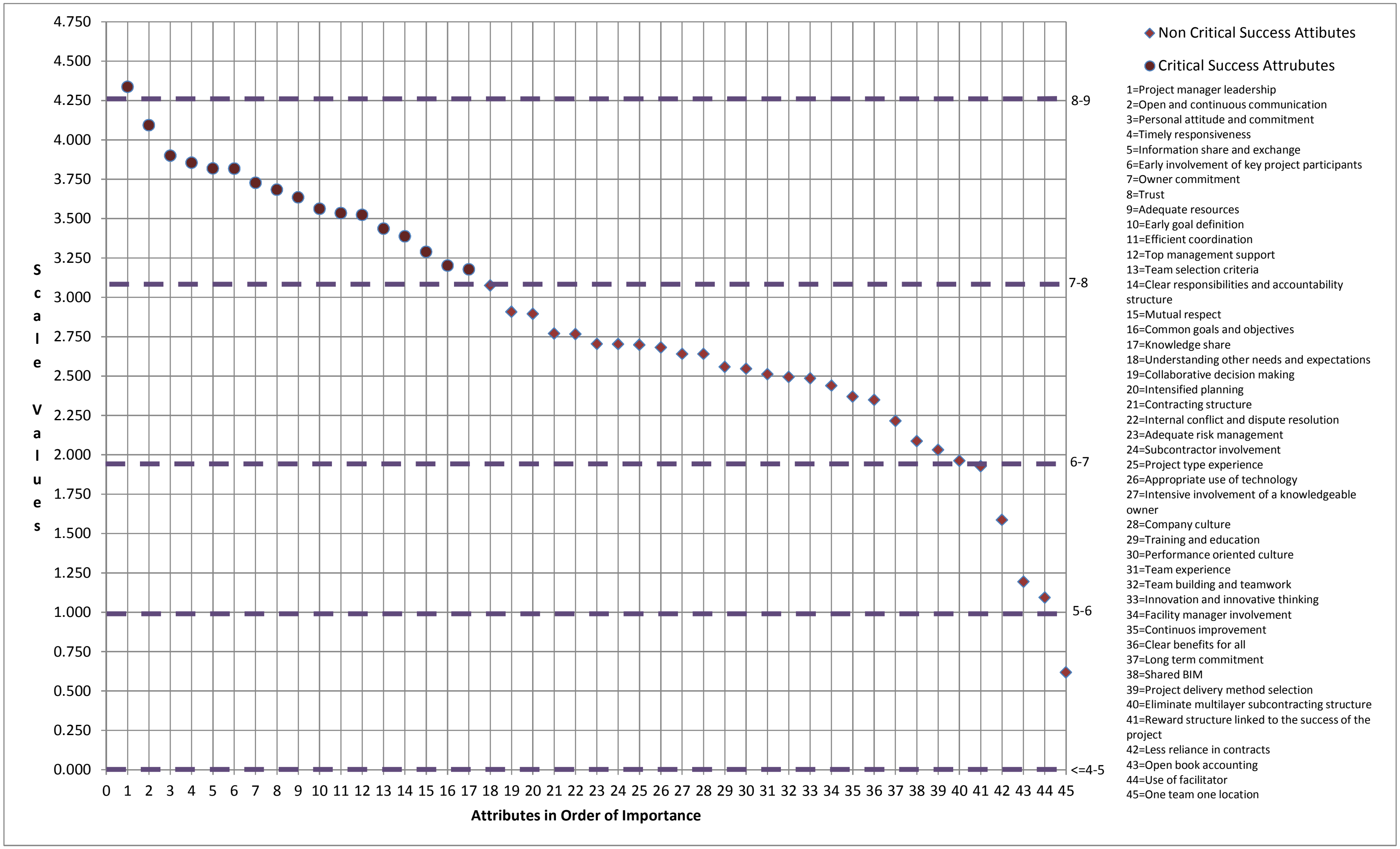

Figure 28- IAs in order of importance to achieve project integration for engineers or specialty consultants

According to the results presented on Figure 28, for the group of engineers and specialty consultants one IA is located below category boundary 2 (1.000), which is "one team one location". This is the same attribute located under category boundary 2 by the group of architects; therefore according to the perception of the design team of the project, locating the team in a single location does not contribute to project integration or it has a very low contribution. There are four IAs that fall between category boundary 2 and category boundary 3 (1.939), indicating that those IAs have a low level of importance for achieving project integration according to engineers and specialty consultants. There are 23 IAs that fall between category boundary 3 and category boundary 4 (3.093), which are the IAs that have a medium level of importance for achieving project integration for engineers or specialty consultants.

In terms of the CSIAs the criterion used to operationally define them is the value of the fourth category boundary, which is 3.093.There are 16 IAs that fall between category boundary 4 and category boundary 5 (4.260), and one IA that falls above category boundary 5, which is "organization and project manager leadership". This IA is the most important IA that has to be in place for achieving an integrated project according to engineers and specialty consultants. This IA does not correspond to the attributes that are in the same location for all other roles and for the complete group of respondents; however it is a CSIA for all of them.

The IAs located on the upper portion of the scale and on the lower portion of the scale are very aligned with the IAs that are in the same location for other roles; however, engineers and specialty consultants used more the medium portion and the lower portion of the rating scale than the other groups of respondents. They consider less IAs to be very important for achieving project integration.

General Contractor + Subs

The analysis was also run for the group of general contractors and subcontractors (N=38). The category boundaries for this group can be found in Table 20, and the list of IAs including their scale values and the standard deviation is found in Table 21. The complete results from this analysis are shown in Appendix L.

Table 20- Category boundaries for general contractors and subcontractors

Category Boundary	1	2	3	4	5
Category boundary Value	0	1	1.855	2.729	3.704

Table 21- Scale value and standard deviation for each IA for general contractors and subcontractors

General Contractor and Subcontractor		
Attribute	**Scale Value**	**Standard Deviation**
Open and continuous communication	4.183	1.440
Early involvement of key project participants	3.767	1.303
Category Boundary 5 = 3.704		
Timely responsiveness	3.558	1.255
Knowledge share	3.549	2.099
Adequate resources	3.516	1.419
Information share and exchange	3.491	1.815
Organization and project manager leadership	3.438	0.980
Trust	3.414	1.378
Owner commitment	3.250	1.168
Atmosphere of mutual respect	3.228	1.472
Early goal definition	3.174	1.780
Personal attitude and commitment	3.158	1.773
Common goals and objectives	3.130	2.080
Clear responsibilities and accountability structure	3.079	1.328
Top management support	3.074	1.920
Subcontractor involvement	3.067	1.483
Intensified planning	3.056	1.784
Team selection criteria	3.038	0.908
Efficient coordination	2.982	1.766

Table 21-Continued

General Contractor and Subcontractor		
Attribute	**Scale Value**	**Standard Deviation**
Project delivery method selection	2.871	1.884
Team experience	2.800	1.802
Internal conflict and dispute resolution	2.733	1.660
Category Boundary 4 = 2.729		
Understanding other needs, expectations and disciplines	2.542	1.500
Innovation and innovative thinking	2.532	1.425
Long term commitment	2.477	2.198
Collaborative decision making	2.473	1.677
Team building and teamwork	2.369	1.529
Project type experience	2.331	1.403
Facility manager involvement	2.256	1.524
Member's company culture	2.241	2.003
Training and education	2.238	1.328
Continuous improvement	2.189	1.496
Clear benefits for all	2.186	1.689
Appropriate use of technology	2.186	1.689
Intensive involvement of a knowledgeable owner	2.170	1.743
Adequate risk management	2.149	1.514
Performance oriented culture	2.083	1.889
Reward structure linked to the success of the project	2.014	1.733
Shared BIM	1.984	1.546
Less reliance in contracts	1.948	2.572
Category Boundary 3 = 1.855		
Eliminate multilayer subcontracting structure	1.753	1.830
Open book accounting	1.450	1.939
One team one location	1.322	1.620
Category Boundary 2 = 1.000		
Use of facilitator	0.691	1.910
Category Boundary 1 = 0.000		

The fit of the model was checked by plotting the probits against the scale values for each category boundary as shown in Figure 29, and by plotting the probits against category boundary for each scale value as presented in Figure 30.

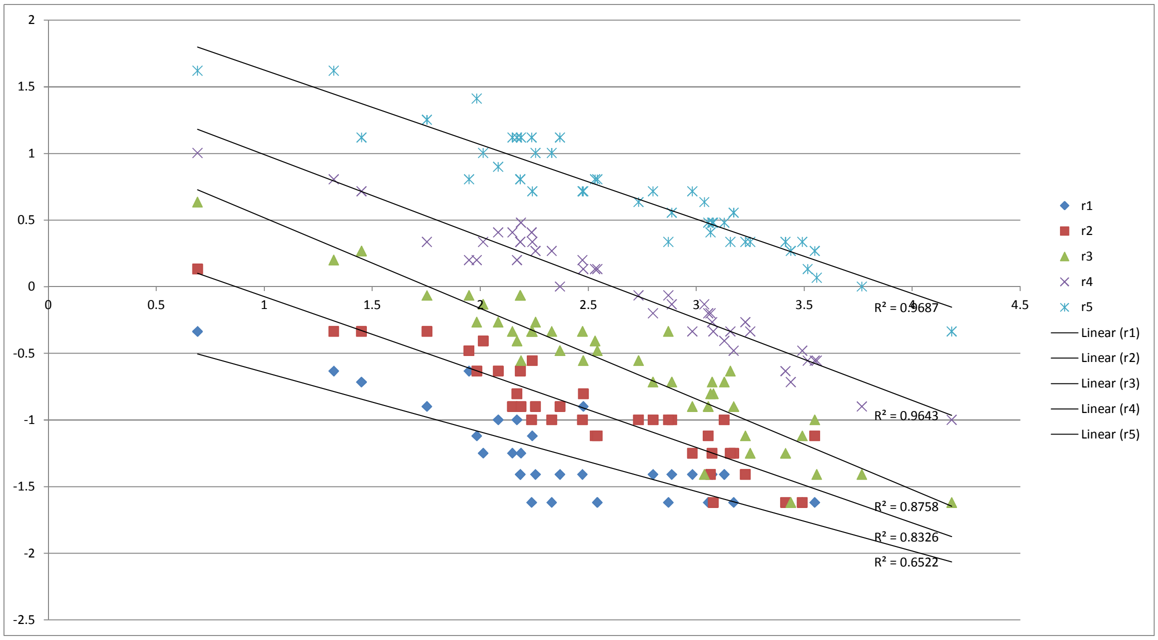

Figure 29- Probits against scale values for each category boundary for general contractors and subcontractors

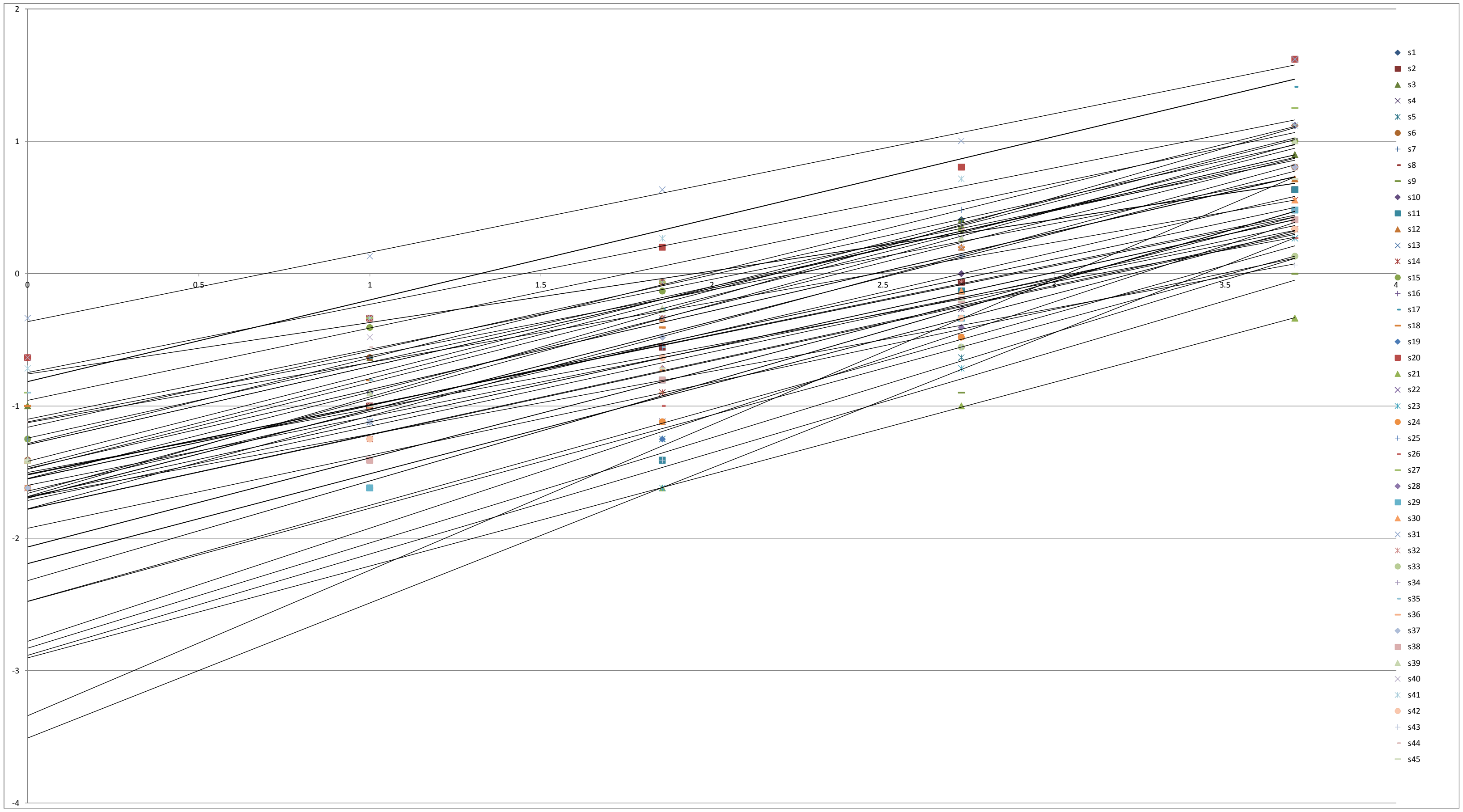

Figure 30- Probits against category boundaries for each IA for general contractors and subcontractors

As observed in Figure 29 the points fall near the regression line, in addition to a large extent the lines are more or less parallel. Moreover, in Figure 30 the points fall near the regression line as well and the lines are clearly crossing. Therefore the assumptions behind the model hold.

The IA organized in order of importance according to their scale value and the category boundaries are presented in Figure 31. The figure also highlights the CSIAs and the non-critical success attributes according to the perceptions of general contractors and subcontractors, the criterion used to operationally define the CSIA is the same used for other roles and for the complete group of respondents, and correspond to category boundary 4 that separates rating categories 7 and 8; which for general contractors and subcontractors has a value of 2.729. Thus the CSIAs are the IAs that general contractors and subcontractors mostly rated 8 or 9.

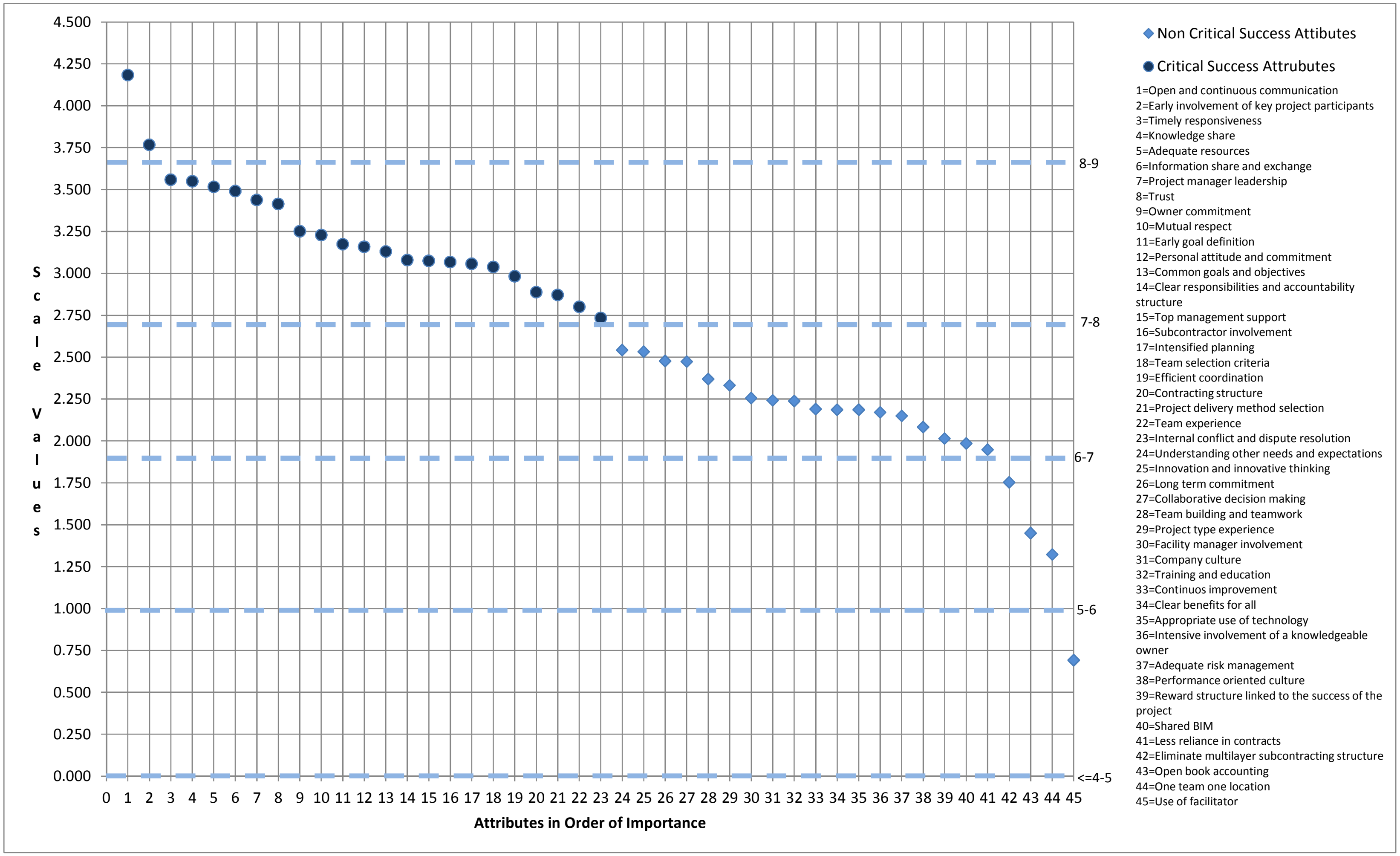

Figure 31- IA in order of importance to achieve project integration for general contractors and subcontractors

As observed in Figure 31 according to the perception of general contractors and subcontractors, there is one IA that falls below category boundary 2 (1.000) that is “use of facilitator”; indicating that for general contractors and subcontractors having a facilitator of the integration process is either neutral or it has a low level of importance. There are three IA that fall between category boundary 2 and category boundary 3 (1.855); these are IAs that have a low level of importance to achieve project integration. There are 18 IA that fall between category boundary 3 and category boundary 4 (2.729), these are IAs that have a medium level of importance for achieving project integration.

As previously mentioned, the criterion selected to operationally define the CSIA is the value of category boundary 4, which for general contractors and subcontractors is 2.729. Therefore all the IAs that fall above that criterion are the IAs mostly rated 8 and 9 by general contractors and subcontractors. There are 21 IAs that fall between category boundary 4 and category boundary 5 (3.704), and there are two IAs that fall above category boundary 5. The two most important IAs for general contractors and subcontractors are “open and continuous communication” and “early involvement of key project participants”. These two IAs are also the most important IAs for the complete group of respondents and for the group of architects; in addition are on the upper portion of the scale for all of the roles.

Although the IAs do not fall in the exact same order in comparison to the complete group of respondents and to other roles, the four IAs that are less important to achieve project integration for general contractors and subcontractors are the same attributes that fall in the lower part of the scale for all of the different roles as well as for the entire group of respondents. In addition, the attributes in the upper portion of the scale are the same as well.

Comparison of the Results of the Thurstone's Successive Interval Procedure for the Different Roles and for the Complete Group of Respondents

In order to compare the scales obtained for the different roles and for the complete group of respondents three different aspects are addressed. First, it is important to identify the IAs where major differences are found across the different groups of respondents. Second, it is important to identify similarities found across groups of respondents; especially in the lower portion of the scale. And third, it is important to discuss the differences and similarities found in terms of the CSIA across groups of respondents. It is important to identify the differences and the similarities especially in the upper portion and in the lower portion of the scales; because the IAs in the upper portion of the scale correspond to the CSIA or IA that are very important for achieving project integration; therefore if an integrated project is to be achieved, more resources should be allocated to implementing those IAs. On the other hand, it is also very important to identify the IA that have a low level of importance or that might be neutral for achieving project integration; as less resources, if any, should be allocated to implement them.

In order to summarize the responses of the different roles and of the complete group of respondents Figure 32 was done. Figure 32 presents the different IAs and their scale value for the complete group of respondents and for each role. As the order of importance of each IA for each role and for the complete group of respondents varies, the order presented in the figure is the order of importance of the IAs for the complete group of respondents, and the IAs for the different roles are plotted in reference to this order. The standard deviation of the scale value for each role and the complete group of respondents, for each IA is presented next to each IA in the figure as well.

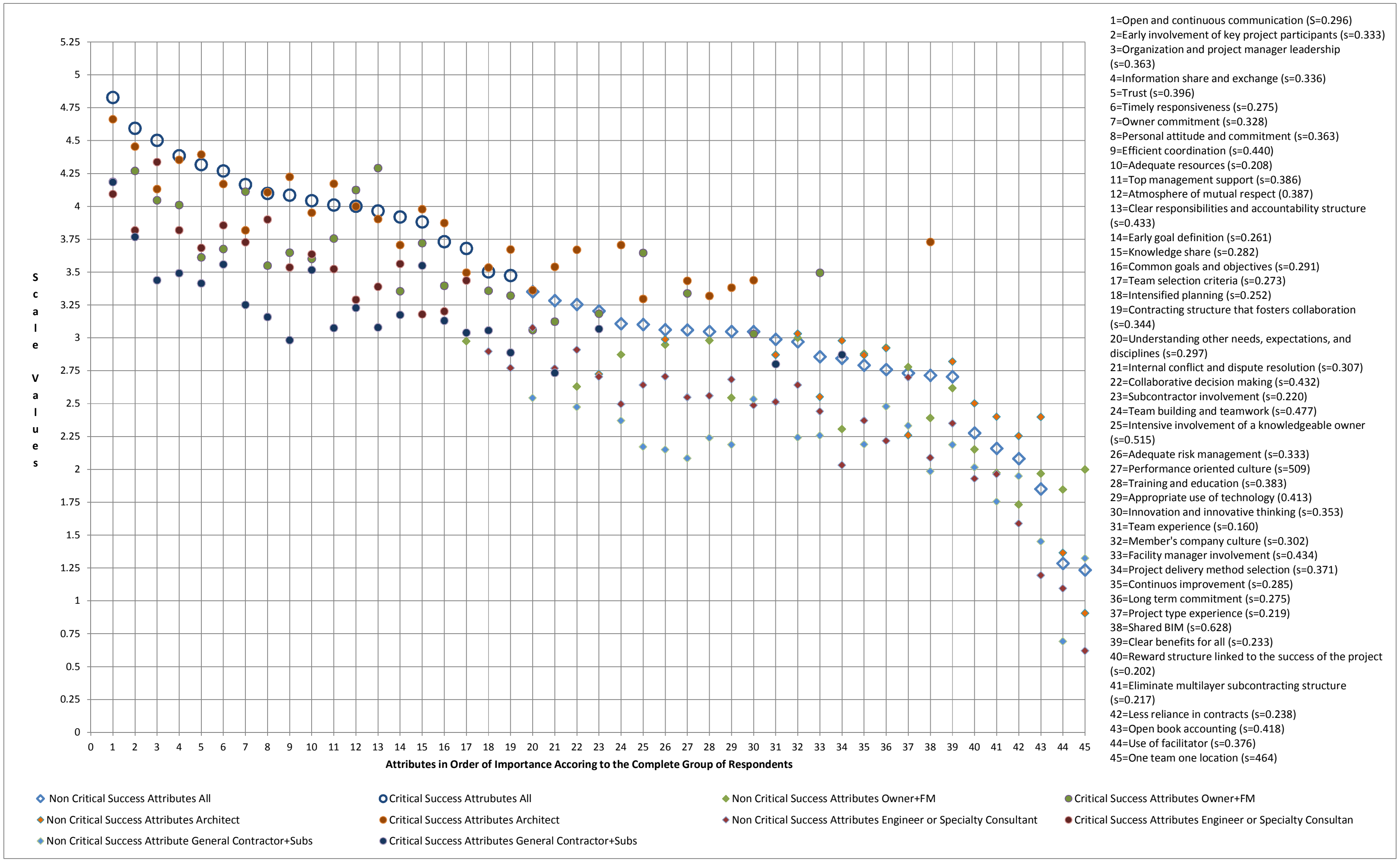

Figure 32- IAs and their scale value for each of the different roles with reference to the complete group of respondents

The standard deviations associated to each IA found in Figure 32 are small for most of the IAs, indicating that the perceptions of importance of the IAs for different roles and of the complete group of respondents are relatively homogeneous. However, there are some IAs that have larger standard deviations in comparison to other IAs.

Major Differences Observed on Integration Attributes Importance across Different Roles According to the Thurstone Scales for Each Role and for the Complete Group of Respondents

The IAs that have a standard deviation of more than 0.47 are "teambuilding and teamwork", "intensive involvement of a knowledgeable owner", "performance oriented culture", and "shared BIM". These are the IAs where larger differences are found in comparison to the rest of the IAs in terms of the scale values.

The largest standard deviation is associated with IA "shared BIM" (0.628). For the purpose of this study it was defined as the use of one building model that has the input of all team members and that can be used by all team members. In the Figure 32, it can be observed that according to the complete group of respondents it has a medium level of importance. For owners and facility managers, general contractors and subcontractors, and engineers and specialty consultants, it also has a medium level of importance; however the scale values of this IA for them are lower. On the other hand, the group of architects considered this IA as very important; for them it is one of the CSIA.

The IA "shared BIM" was included in the study as result of the industry meeting. Before the use of BIM was included as part of the "appropriate use of technology" attribute; however industry practitioners who participated of the meeting thought that it was very important and that should be an attribute by itself.

The second largest standard deviation is associated with the IA "intensive involvement of a knowledgeable owner" (0.515). It was defined for the purpose of this study as the active role the owner should have during the design and construction, in order to have regular feedback between the owner and the rest of the team. According to the perception of owners and facility managers and architects, this IA is very important for project integration; for both groups this is considered a CSIA. On the other hand, engineers or specialty consultants, general contractors and subcontractors, and the complete group of respondents have the perception that this IA has a medium level of importance for achieving project integration.

"Intensive involvement of a knowledgeable owner" was included as part of this study because AIA National and AIA California Council (2007), CURT (2004), Dainty, et al. (2001), Egan (1998), Lichtig (2005), O'Connor (2009), Rahman and Kumaraswamy (2004), Tang (2001), and Busby Perkins and Will and Santec Consulting (2007) considered it influential for project integration.

Another IA that also has a large standard deviation is "performance oriented culture" (0.509); which is defined for the purpose of this study as setting performance of the project and performance of the team as important objectives that are continuously measured and assessed against clear targets. This IA is very important according to the perception of owners and facility managers, and architects. However, according to the perceptions of the complete group of respondents, the engineers or specialty consultants, and the general contractors and subcontractors, this IA has a medium level of importance for achieving project integration.

"Performance oriented culture" was considered important for project integration by Egan (1998), Knight (2008), Kumaraswamy, et al. (2005), Lichtig (2005), Rahman and Kumaraswamy (2004), Rooney (2006), Tang (2001), Thompson and Sanders (1998), and Busby Perkins and Will and Santec Consulting (2007).

Another IA that has a different behavior depending on the role of the respondents is "team building and teamwork", which standard deviation is 0.477. It is defined in this study as having in place strategies to encourage interdisciplinary groups where team members can contribute beyond their profession, by building relationships and trust among them. In terms of the groups of respondents, architects have the perception that it is very important, and it is a CSIA for them. On the other hand all other groups of respondents and the complete group of respondents, consider this IA of medium importance for achieving project integration; however the scale values for the complete group of respondents and the group of owners and facility managers, associated with this IA are higher than the scale values for engineers or specialty consultants and general contractors and subcontractors.

"Team building and teamwork", was included as part of this study because Tang (2001), Kumaraswamy et al. (2005), Sun and Aouad (2000), Baiden et al. (2006), Koutsikouri et al. (2008), Chan et al. (2004), Busby Perkins and Will and Santec Consulting (2007), Dulami et al. (2002), Glagola and Sheedy, Kumaraswamy et al. (2005), Lichtig (2005), Mitroupolos and Tatum (2000), Thompson and Sanders (1998), O'Connor (2009), Rahman and Kumaraswamy (2004), Rooney (2006), and Whaley (2009), stated that this attribute is influential for project integration.

Similarities Observed on Integration Attributes in the Lower Portion of the Thurstone Scales across Different Roles and the Complete Group of Respondents

It is also important to identify the similarities and differences observed in the IAs that have a low level of importance or that might be neutral for achieving project integration.

There are six IAs that are located in the lower portion of the scale for all of the roles and for the complete group of respondents. These IAs are "reward structure linked to the success of the team", "eliminate multilayer subcontracting structure", "less reliance in contracts", "open book accounting", "use of facilitator", and "one team one location".

Most of the respondents agree that the two attributes that are less important or very close to neutral for achieving project integration are "one team one location" and "use of facilitator". The only group that considers other attributes as less important is the group of owners and facility managers; however even they locate these attributes in the lower part of the scale as well.

"One team one location" was defined in this study as setting a certain place where team members can move to work in a collaborative environment where communication is facilitated and skills and knowledge are combined in a group.

Baiden, et al. (2006), Sun and Aouad (2000), Thompson and Sanders (1998), and Whaley (2009) suggested that moving a team to a certain location could help to improve integration. However, the perception of most of the respondents is that locating the team in one single place, does not contribute to project integration, or if it contributes is certainly in a very small amount.

"Use of facilitator" was defined for the purpose of this study as having a person who can help develop communication skills, foster respect and trust, guide the project team in the integration process, align individual goals and project goals, eliminate the fear of conflict, get commitment from the different stakeholders, make each party accountable for their responsibilities, and have leadership skills.

This attribute was found to be important for project integration for Glagola and Sheedy (2002), Knight (2008), Mitropoulos and Tatum (2000), Rahman and Kumaraswamy (2004), Whaley (2009), and Busby Perkins and Will and Santec Consulting (2007).

The IA "open book accounting" is located in the lower portion of the scale by all of the roles and for the complete group. However, the perceptions of the different groups are more disperse. The complete group of respondents, owners and facility managers, and architects located this IA in a medium level of importance; however the scale values associated with the complete group and with owners and facility managers are lower than the scale value associated with architects. On the other hand, the group of general contractors and subcontractors and of engineers and specialty consultants locate this IA in a low level of importance or close to neutral for achieving project integration. "Open book accounting" was defined for the purpose of this study as having in place a transparent financial structure where all expenses and costs are explicit to team members.

"Open book accounting" was identified by Eagan (1998), Rooney (2006), and Skal (2005) as important for achieving project integration; however for most of the respondents this IA falls in the three least important IAs, and for all of them it falls in the lower portion of the scale.

The IA "less reliance in contracts" also falls in the lower portion of the scale for all the groups of respondents. It is the least important attributes for the group owners and facility managers, even though the scale value associated with engineers or specialty consultants is lower. "Less reliance in contracts" was defined in this study as the ability of the team to interact, collaborate and support the project beyond the contract requirements and constraints.

Eagan (1998) and Martin and Songer (2004) affirm that relying less in contracts is important for improving project integration; however the respondents of this study located this attribute in the lower part of the importance scale.

The IA "eliminate multi-layer subcontracting structure" also falls in the lower portion of the scale for all of the groups of respondents. General contractors and subcontractors have the perception that it has a low impact on project integration. All other groups located it in the lower part of the medium level of importance. The scale values associated with owners and facility managers, and engineers and specialty consultants are lower compared with the complete group of respondents, while the scale value associated with architects is higher but still in the lower portion of the scale. "Eliminating multi-layer subcontracting structure", is defined for this study as having in place a structure where the general contractor or the project manager hires directly the subcontractor that is going to perform the work increasing the accountability of parties involved.

"Eliminating multi-layer subcontracting structure" was included as part of this study because Tang (2001) stated that it could be influential for project integration; however respondents of this study place it in a low level of importance for achieving project integration.

The IA "reward structure linked with the success of the project" is also located in the lower portion by most groups of respondents. Engineers and specialty consultants located it in a low level of importance; while the rest of the groups located it in the lower part of the medium level of importance. Linking the reward structure to the success of the project was defined in this study as having in place a payment structure that links the financial success of each project member to the success of the project.

In literature it was found that linking the reward structure to the success of the project is important to project integration (AIA National and AIA California Council 2007, CURT 2004, Egan 1998, Lichtig 2005, Mitropoulos and Tatum 2000, Rahman and Kumaraswamy 2004, Rooney 2006, Skal 2005, Tang 2001, Thompson and Sanders 1998, Busby Perkins and Will and Santec Consulting 2007); however the perception of respondents is that it only has a low level of importance, and this IA is not critical for achieving project integration.

Differences and Similarities on the Critical Success Attributes for Achieving Project Integration across the Different Roles and the Complete Group of Respondents

As previously stated the criterion used to operationally define critical success attributes for achieving project integration (CSIAs) consists of identifying all the integration attributes (IA) that fall above the fourth category boundary (i.e., the boundary that separates rating categories 7 and 8), which are the IA mostly rated 8 and 9 by the respondents. Therefore there are different critical success attributes for the complete group of respondents and for each different role. The CSIAs for each role and for the complete group of respondents can be observed in the upper portion of Figure 32. In addition, to visualize the differences and similarities on the CSIA found across roles and the complete group of respondents Table 22, Table 23, Table 24, and Table 25 were done. Each of these tables corresponds to one group, and compares CSIAs for that specific group with the critical success attributes of the rest of the groups. Thus the color of the intersecting cell between the IA and the group of respondents has a meaning. The meaning of a green cell is that the specific attribute is also a critical success attribute for the group of respondents that corresponds that cell. On the other hand the meaning of a red cell is that the specific attribute is not a critical success attribute for the group of respondents that corresponds to that cell. For the purpose of the tables, the group All corresponds to the complete group of respondents, O+FM corresponds to owners + facility managers, A corresponds to architects, E or SC corresponds to engineers or specialty consultants, and GC+S corresponds to general contractors + subcontractors.

Table 22- CSIAs according to the complete group of respondents (CB=3.350) in comparison to the CSIA of the different groups of respondents (O+FM = owners + facility managers, A = architects, E or SC = engineers or specialty consultants, and GC+S = general contractors + subcontractors)

Group: All					
Scale Value	**Attribute**	**O+FM**	**A**	**E or SC**	**GC+S**
4.828	Open and continuous communication				
4.593	Early involvement of key project participants				
4.501	Organization and project manager leadership				
4.384	Information share and exchange				
4.317	Trust				
4.269	Timely responsiveness				
4.165	Owner commitment				
4.098	Personal attitude and commitment				
4.085	Efficient coordination				
4.043	Adequate resources				
4.010	Top management support				
4.000	Atmosphere of mutual respect				
3.964	Clear responsibilities and accountability structure				
3.919	Early goal definition				
3.881	Knowledge share				
3.731	Common goals and objectives				
3.679	Team selection criteria				
3.501	Intensified planning				
3.474	Contracting structure that fosters collaboration				

According to Table 22, most of the CSIA considered by the complete group of respondents are also part of the critical success attributes considered by each occupational segment. There are three IAs that are CSIAs for the complete group of respondents, which are not CSIAs for one of the roles. These IAs are "team selection criteria", which not considered CSIA by owners and facility managers; and "intensified planning" and "contracting structure that fosters collaboration", which are not considered CSIA by engineers and specialty consultants.

"Team selection criteria" was defined as a procedure of team selection not solely cost-based, but that includes other relevant criteria such as qualifications, previous experience, ability and commitment to participate in an integrated team, willingness to commit to shared-risk ideas, open communication and creation of a no-blame culture. In Figure 32, it can be observed that it rates very close to the other groups, and the reason it is not among the CSIA for facility managers and owners is that it is slightly below the criterion of category boundary 4 (3.12).

In addition, the two IAs that are considered CSIA for all of the groups of respondents, except for engineers or specialty consultants are “intensified planning” and “contracting structure”. The first one was defined as setting the project phases in a way that more time and effort is allocated to the planning phase and to other earlier phases. The second was defined as an agreement that sets how the different parties are going to interact in the project and who is responsible to whom, in a way that fosters collaboration and communication, integrating the efforts of the entire team. In both cases in Figure 32 it can be observed that they rate slightly below category their fourth category boundary (3.093) and rate very close to the responses of other groups of respondents.

It is important to note that the three IAs that were not completely aligned with the perceptions of the different groups are the IA that are the least important CSIAs. Additionally, the discrepancy is just with one group of respondents for each of these IAs. There are not CSIA with discrepancy of more than one group of respondents.

Table 23- CSIAs according to group owners and facility managers (CB4=3.120) in comparison to the CSIA of the different groups of respondents (O+FM = owners + facility managers, A = architects, E or SC = engineers or specialty consultants, and GC+S = general contractors + subcontractors)

Group: Owner + Facility Manager					
Scale Value	**Attribute**	**All**	**A**	**E or SC**	**GC+S**
4.290	Clear responsibilities and accountability structure				
4.269	Early involvement of key project participants				
4.187	Open and continuous communication				
4.124	Atmosphere of mutual respect				
4.112	Owner commitment				
4.046	Organization and project manager leadership				
4.010	Information share and exchange				
3.755	Top management support				
3.719	Knowledge share				
3.675	Timely responsiveness				
3.648	Efficient coordination				
3.645	Intensive involvement of a knowledgeable owner				
3.611	Trust				
3.600	Adequate resources				
3.549	Personal attitude and commitment				
3.494	Facility manager involvement				
3.395	Common goals and objectives				
3.357	Intensified planning				
3.354	Early goal definition				
3.338	Performance oriented culture				
3.320	Contracting structure that fosters collaboration				
3.183	Subcontractor involvement				
3.123	Internal conflict and dispute resolution				
3.059	Understanding other needs, expectations and disciplines				
3.029	Innovation and innovative thinking				

When analyzing the first 11 critical success attributes for the group of owners and facility managers in Table 23, there are no discrepancies between these CSIAs and the CSIAs of the other groups. In addition most of the discrepancies are found in the critical success attributes that are less important for owners and facility managers, as most of the red cells are located in the lower part of the table, very close to the category boundary 4. However, there are two differences that are located in the medium part of the table or two attributes that are really important for this group of respondents, but that probably are not for other respondents. The first discrepancy found is in regard to the IA "intensive involvement of a knowledgeable owner" as this is an IA that falls in the category of attributes with medium to high level of importance for most of the respondents. However, architects and owners and facility managers think that their involvement is very important. The second discrepancy is in regard to the attribute "facility manager involvement". According to Figure 32, this discrepancy is more notorious as this attribute is considered to have a medium level of importance for most of the respondents, but is very important for the group of owners and facility managers.

There are two discrepancies just with the group of engineers or specialty consultants as they do not consider "intensified planning" and "contracting structure that fosters collaboration" as CSIA, while the rest of respondents do. These two IAs are slightly below the criterion of category boundary 4 (3.093) for engineers and specialty consultants.

There are other IAs which only the architects and the owners and facility managers consider CSIA. These IAs are "performance oriented culture", which is in the medium level of importance for the complete group, it is less important for the group of engineers and specialty consultants, and it is even less important for general contractors and subcontractors. "Understanding other's needs, expectations and disciplines", which is right on the criterion of category boundary 4 (3.350) for the complete group of respondents, and is in the medium to high level of importance for the group of engineers and specialty consultants; however it is less important for the group of general contractors and subcontractors. And "innovation and innovative thinking", which has a medium level of importance for all other respondents.

There is one IA that is considered a CSIA for owners and facility managers and for general contractors and subcontractors that is “subcontractor involvement”, which according to Figure 32 is in a medium to high level of importance for the complete group of respondents, for engineers and specialty consultants and for architects. There is one final discrepancy found in the attribute “internal conflict and dispute resolution” where owners and facility managers, architects, and general contractors and subcontractors consider it a critical success attribute, while for the complete group of respondents and for the engineers and specialty consultants fall very close to the criterion of category boundary 4 (3.350 and 3.093 respectively), but below it, indicating that its importance is medium to high.

It is important to note that architects agree most to owners and facility managers with respect to what the CSIA are.

Table 24- CSIA according to group architects (CB4=3.293) in comparison to the CSIA of the different groups of respondents (O+FM = owners + facility managers, A = architects, E or SC = engineers or specialty consultants, and GC+S = general contractors + subcontractors)

Group: Architect					
Scale Value	**Attribute**	**All**	**O+FM**	**E or SC**	**GC+S**
4.662	Open and continuous communication				
4.454	Early involvement of key project participants				
4.393	Trust				
4.353	Information share and exchange				
4.224	Efficient coordination				
4.171	Top management support				
4.169	Timely responsiveness				
4.131	Organization and project manager leadership				
4.106	Personal attitude and commitment				
3.999	Atmosphere of mutual respect				
3.978	Knowledge share				
3.951	Adequate resources				
3.903	Clear responsibilities and accountability structure				
3.873	Common goals and objectives				
3.817	Owner commitment				
3.729	Shared BIM				
3.705	Team building and teamwork				
3.705	Early goal definition				
3.671	Contracting structure that fosters collaboration				
3.669	Collaborative decision making				
3.539	Internal conflict and dispute resolution				
3.534	Intensified planning				
3.495	Team selection criteria				
3.438	Innovation and innovative thinking				
3.434	Performance oriented culture				
3.381	Appropriate use of technology				
3.361	Understanding other needs, expectations, and disciplines				
3.318	Training and education				
3.296	Intensive involvement of a knowledgeable owner				

The number of CSIAs for the group of architects is the highest among all the groups of respondents. One reason for this is that the architects used the 8 and 9 ratings more, often more attributes rated above the criterion of the 4th category boundary (3.293). They consider more attributes to contribute to project integration in an important way. The first 15 CSIA for architects are consistently defined as critical in all groups of respondents. As with owners and facility managers, most of the discrepancies or red cells are found in the lower part of the table where attributes have lower scale values.

There are two attributes that fall around the middle of the table, that are very important for the architects, however for the rest of the group they have a different behavior. The first one is "shared BIM", this is the attribute which has the largest difference between respondents in the entire study, as stated previously for architects it is very important, while for the complete group and for owners and facility managers has a medium importance and for engineers or specialty consultants has a lower importance. The second difference of this type is in regard to the attribute "team building and team-work", as it is very important for the architects, has a medium to high importance for the complete group and for the group of owners and facility managers, and has a lower importance for the engineers or specialty consultants and for general contractors and subcontractors.

As previously stated architects agree most with owners and facility managers, therefore many of the differences observed in Table 24 were already identified when discussing the differences associated with the group of owners and facility managers. There are three discrepancies between architects and the rest of the groups that should be discussed even though they are located in the lower part of the table. One is in regard to the attribute "collaborative decision making", which for the complete group has a medium to high level of importance and is very close to the criterion of category boundary 4 (3.350), however for the other three groups of respondents it has a lower level of importance. Another discrepancy is in regard to the attribute "appropriate use of technology" which has a medium level of importance for the rest of respondents. Finally, the attribute “training and education” has also a discrepancy between the architects and the rest of respondents, as they rate it as a medium importance attribute. Again, most of the differences between this group and the rest of groups are because there are more critical success attributes according to architects, as they rated higher more attributes.

Table 25- CSIAs according to group engineers or specialty consultants (CB4=3.093) in comparison to the CSIAs of the different groups of respondents (O+FM = owners + facility managers, A = architects, E or SC = engineers or specialty consultants, and GC+S = general contractors + subcontractors)

Group: Engineer or Specialty Consultant					
Scale Value	**Attribute**	**All**	**O+FM**	**A**	**GC+S**
4.337	Organization and project manager leadership				
4.093	Open and continuous communication				
3.900	Personal attitude and commitment				
3.855	Timely responsiveness				
3.818	Information share and exchange				
3.817	Early involvement of key project participants				
3.727	Owner commitment				
3.683	Trust				
3.635	Adequate resources				
3.562	Early goal definition				
3.535	Efficient coordination				
3.523	Top management support				
3.436	Team selection criteria				
3.388	Clear responsibilities and accountability structure				
3.289	Atmosphere of mutual respect				
3.201	Common goals and objectives				
3.178	Knowledge share				

Opposite to the number of CSIAs identified by the group architect, the group engineer or specialty consultant identified the lowest number of CSIAs. In general they did not rate so many attributes 8 or 9, and consequently their criterion of category boundary 4 (3.093) was met less frequently. Therefore all of the attributes identified by them as critical are typically the same identified by the rest of the group analyses. The only difference is in regard to the attribute “team selection criteria” that is a critical success attribute for the complete group of respondents and for all of the groups, but for the group of owners and facility managers. As mentioned earlier this is an attribute that is very close to the criterion of category boundary 4 for owners and facility managers.

Table 26- SCIAs according to group of general contractors and subcontractors (CB4=2.729) in comparison to the CSIAs of the different groups of respondents (O+FM = owners + facility managers, A = architects, E or SC = engineers or specialty consultants, and GC+S = general contractors + subcontractors)

Group: General Contractor and Subcontractors					
Scale Value	**Attribute**	**All**	**O+FM**	**A**	**E or SC**
4.183	Open and continuous communication				
3.767	Early involvement of key project participants				
3.558	Timely responsiveness				
3.549	Knowledge share				
3.516	Adequate resources				
3.491	Information share and exchange				
3.438	Organization and project manager leadership				
3.414	Trust				
3.250	Owner commitment				
3.228	Atmosphere of mutual respect				
3.174	Early goal definition				
3.158	Personal attitude and commitment				
3.130	Common goals and objectives				
3.079	Clear responsibilities and accountability structure				
3.074	Top management support				
3.067	Subcontractor involvement				
3.056	Intensified planning				
3.038	Team selection criteria				
2.982	Efficient coordination				
2.887	Contracting structure that fosters collaboration				
2.871	Project delivery method selection				
2.800	Team experience				
2.733	Internal conflict and dispute resolution				

In terms of the CSIAs for the group general contractors and subcontractors, the 15 first CSIAs are perfectly aligned with the CSIAs of all of the groups of respondents, including the complete group of respondents. And most of the discrepancies or red cells are found in the lower part of the table, meaning that they fall very close to the criterion of category boundary 4. Most of the discrepancies observed in Table 26, are discrepancies of more than one occupancy segment; therefore they have already been identified. However there are two attributes that are considered CSIAs, which are not CSIAs for the rest of respondents. One of these is “project delivery method selection” that has a medium level of importance to the rest of respondents; one possible explanation is that this is the group of respondents that is usually more affected by the project delivery method selected. The other is “team experience” that is also considered of medium importance for the rest of the group.

In summary, Tables 22-26 indicate that the responses of all the groups are relatively homogeneous, and that the CSIA selected by the complete group of respondents are arguably consistent with the perception of the various occupation groups. There is only one attribute “internal conflict and dispute resolution”, that is not part of the CSIAs for the complete group and that is considered by three groups of respondents: owners and facility managers, architects, and general contractor and subcontractor, as critical to successfully achieve integration.

Analysis of Variance

In order to confirm the results obtained with the scaling procedure in regard to the homogeneity of the importance of the different attributes to achieve project integration across groups of respondents, an analysis of variance was performed for each of the 45 IAs. The main objective of this analysis was to identify if there are any significant mean differences among groups of respondents in regard to the importance raw ratings of each IA. It is important to take into consideration that the analyses were done considering each attribute as independent and without controlling for Type I error across the different tests. Therefore, it is possible that the null hypothesis of no population differences was rejected too frequently.

Even without controlling for Type I error across the 45 tests, there are just 8 attributes, out of the 45, where a significant difference is found at a significance level of 0.05. The eight attributes are organized in order of the smallest p-value to the largest p-value. The attributes and the p-value are presented in Table 27. The results of the analysis of variance for the 45 IAs are shown in Appendix M.

Table 27-Results of the ANOVA of the attributes that have a significant difference without controlling for Type I error across tests

Attribute		Sum of Squares	df	Mean Square	F	Sig.
Shared BIM	Between Groups	40.829	3	13.61	4.315	0.006
	Within Groups	605.595	192	3.154		
	Total	646.423	195			
Performance oriented culture	Between Groups	24.737	3	8.246	3.517	0.016
	Within Groups	452.431	193	2.344		
	Total	477.168	196			
Involvement of a knowledgeable owner	Between Groups	27.635	3	9.212	3.266	0.022
	Within Groups	544.335	193	2.82		
	Total	571.97	196			
Efficient coordination	Between Groups	15.622	3	5.207	3.027	0.031
	Within Groups	333.692	194	1.72		
	Total	349.313	197			
Mutual respect	Between Groups	13.65	3	4.55	2.921	0.035
	Within Groups	302.214	194	1.558		
	Total	315.864	197			
Subcontractor involvement	Between Groups	16.479	3	5.493	2.767	0.043
	Within Groups	383.135	193	1.985		
	Total	399.614	196			
Delivery method selection	Between Groups	24.279	3	8.093	2.712	0.046
	Within Groups	575.853	193	2.984		
	Total	600.132	196			
Open book accounting	Between Groups	35.045	3	11.682	2.691	0.048
	Within Groups	837.828	193	4.341		
	Total	872.873	196			

Figure 33, Figure 34, Figure 35, Figure 36, Figure 37, Figure 38, Figure 39, and Figure 40 present the plot of the mean rating for each IA that exhibited a significant difference across the groups of respondents without controlling for Type I error across tests.

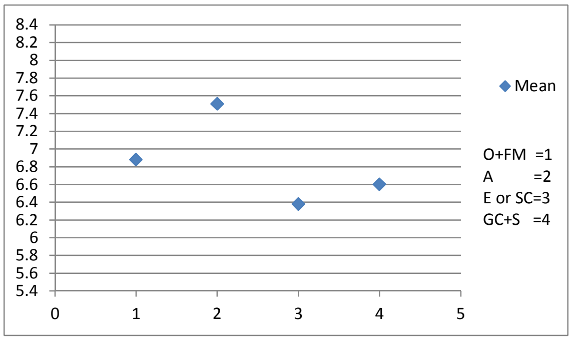

Figure 33-Plot of means for "shared BIM"

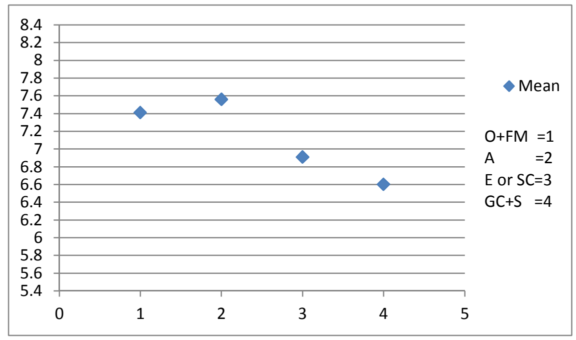

Figure 34-Plot of means for "performance oriented culture"

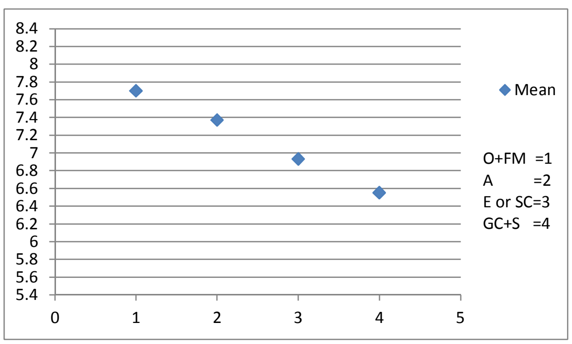

Figure 35-Plot of means for "involvement of a knowledgeable owner"

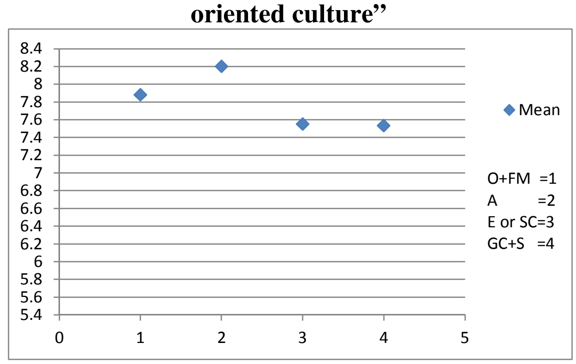

Figure 36-Plot of means for "efficient coordination"

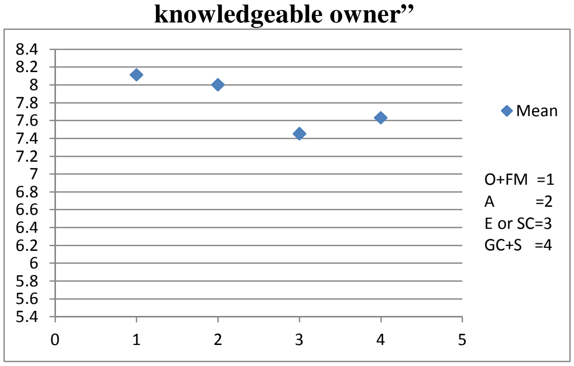

Figure 37-Plot of means for "atmosphere of mutual respect"

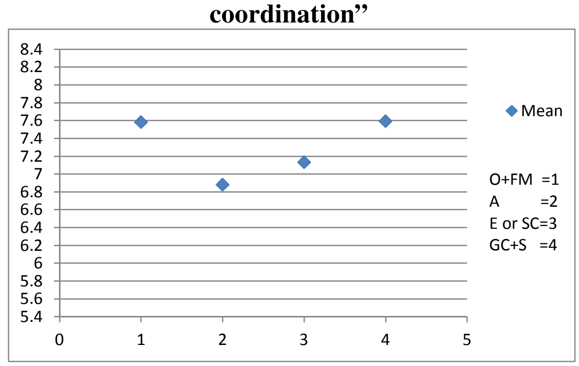

Figure 38-Plot of means for "subcontractor involvement"

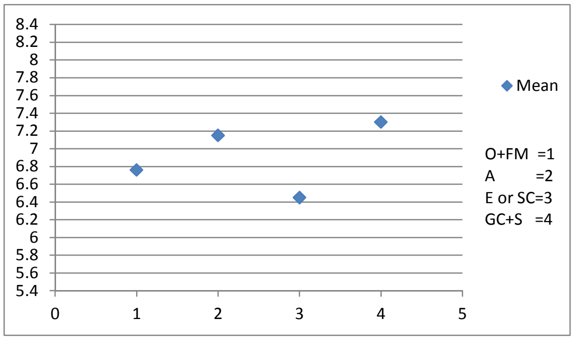

Figure 39-Plot of means for "delivery method selection"

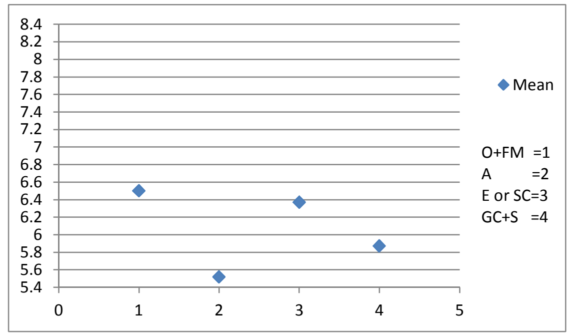

Figure 40- Plot of means for "open book accounting"

This analysis of variance confirms the results already obtained in the previous analyses. First, the number of significant different IAs, even though type I error across tests is not being controlled, are just 8 out of 45 IAs, indicating that the perception across all the groups of respondents in regard to the importance of each attribute for achieving project integration is relatively homogeneous. Second, even though the numbers of differences of perceptions among project participants are very few, there are some attributes which certainly present differences.

One of the main differences among project participants is in regard to the IA "shared BIM", as observed in Figure 32 is has the largest standard deviation (0.628). In order to understand the actual group or groups that statistically differ, a Tukey multiple comparison test was performed. The only statistically significant difference was found between the means of architects and engineers and specialty consultants (p=0.003). According to Figure 33, architects think that IA "shared BIM" is more important for achieving project integration than engineers or specialty consultants do. The mean of the raw data of importance of "shared BIM" for architects is 7.52, while for engineers or specialty consultants is 6.38 in a 9 points rating scale.

The second significant difference is in regard to the IA "performance oriented culture". After performing a Tukey multiple comparison test, the groups that have a statistically significant difference on the mean of importance of “performance oriented cultures” for achieving project integration are architects and general contractors and subcontractors (p=0.031). As observed in Figure 34, architects think that IA “performance oriented culture” is more important for achieving project integration than general contractors and subcontractors do. The mean of the raw rating for importance for architects is 7.52 in a 9 point rating scale; while the mean for general contractors and subcontractors is 6.56.

In terms of the differences on the attribute “intensive involvement of a knowledgeable owner”, the Tukey multiple comparison test was performed as well. There is a statistically significant difference between the mean of the importance of “intensive involvement of a knowledgeable owner” for owners and facility managers and general contractors and subcontractors (p=0.027). Owners and facility managers think that implementing this IA is more important for achieving project integration, than general contractors and subcontractors do. The mean of the importance raw ratings for owners and facility managers is 7.68, while the mean for general contractors and subcontractors is 6.56 in a 9 point rating scale.

A Tukey multiple comparison test was run for IA “efficient coordination”. One statistically significant difference was found between the group of architects and engineers or specialty consultants (p=0.045). According to Figure 36, architects think that “efficient coordination” is more important for achieving project integration than engineers or specialty consultants do; however both means are high, the mean associated with the group of architects is 8.2, while the mean associated with engineers or specialty consultants is 7.57 in a 9 point rating scale.

A Tukey multiple comparison test was performed for IAs "atmosphere of mutual respect", "subcontractor involvement", "delivery method selection", and for "open book accounting" as well; however no significant differences were found for the mean of the raw data of importance for any pair of groups; indicating that it is possible that the means are equal for each pair of those IAs; and the statistical significance of the difference on the omnibus test was to differences on other contrasts different to pair comparisons; which are the comparisons relevant to this study.

Comparison of the Results of the Thurstone Scale for the Complete Group of Respondents and the Conceptual Model

The conceptual framework of this study was based on an extensive literature review and was based on a comprehensive list of attributes that different authors had previously identify as influential for project integration; therefore it is important to assess if there is any relationship between the number of authors that considered each attribute as influential for project integration, and the level of importance associated to that attribute as a result of this research. The list of the authors that have considered any of the IAs as influential for project integration is presented in Chapter 5. The IA that had the smallest number of citations had one citation, while the IA that had the largest number of citations had 19. Table 28 shows the IA in order of importance according to the perception of respondents based on their scale value, the number of authors from the literature review that considered each IA as influential for project integration, and the mean, median, and standard deviation of the number of authors for the group of IAs that are between category boundaries. For the purpose of the table Cit means citations and IM industry meeting.

Table 28- List of IA in order of importance including the number of authors that considered each IA influential for project integration (Cit=citations, IM=industry meeting)

Attribute	Scale Value	Cit Number	Cit Median	Cit Mean	Cit. Stdev
Open and continuous communication	4.828	15	15	15	-
Fifth Category Boundary = 4.729					
Early involvement of key project participants	4.593	12	8	9.11	4.47
Organization and project manager leadership	4.501	6			
Information share and exchange	4.384	11			
Trust	4.317	19			
Timely responsiveness	4.269	2			
Owner commitment	4.165	9			
Personal attitude and commitment	4.098	7			
Efficient coordination	4.085	5			
Adequate resources	4.043	3			
Top management support	4.010	8			
Atmosphere of Mutual respect	4.000	19			
Clear responsibilities and accountability structure	3.964	7			
Early goal definition	3.919	7			
Knowledge share	3.881	8			
Common goals and objectives	3.731	12			
Team selection criteria	3.679	10			
Intensified planning	3.501	7			
Contracting structure that fosters collaboration	3.474	12			
Fourth Category Boundary =3.350					
Understanding other needs, expectations, and disciplines	3.350	8	7.5	7.5	4.22
Internal conflict and dispute resolution	3.283	9			
Collaborative decision making	3.253	10			
Subcontractor involvement	3.204	7			
Team building and teamwork	3.107	16			
Intensive involvement of a knowledgeable owner	3.101	9			
Adequate risk management	3.061	15			
Performance oriented culture	3.059	8			
Training and education	3.048	7			
Appropriate use of technology	3.048	14			
Innovation and innovative thinking	3.047	8			
Team experience	2.988	IM			
Member's company culture	2.969	3			
Facility manager involvement	2.856	1			
Project delivery method selection	2.844	3			
Continuous improvement	2.792	6			
Long term commitment	2.759	6			
Project type experience	2.732	IM			
Shared BIM	2.714	IM			
Clear benefits for all	2.704	6			
Reward structure linked to the success of the project	2.276	11			
Eliminate multilayer subcontracting structure	2.159	1			
Less reliance in contracts	2.081	2			
Third Category Boundary = 2.036					
Open book accounting	1.850	3	4	4	0.82
Use of facilitator	1.284	5			
One team one location	1.234	4			
Second Category Boundary = 1.000					
First Category Boundary = 0.000					

The mean and the median for each group of IAs that are located between category boundaries, suggest that IAs that fall between higher categories had more citations in the literature review. However, the standard deviations of the number of citations for the two groups that include most of the IAs are high. A t-test was performed to determine if the difference between the means of those two groups is statistically significant. The p-value for this analysis is 0.2446; therefore at a significance level of 0.05, it is possible that both means are equal. Thus it seems that there is not a clear relationship between the numbers authors that considered each IA as influential to project integration, and the importance level according to the perception of respondents.

In addition it is important to point out that there are two IAs that are considered to be CSIA, that were considered influential to project integration just by two authors and by three authors. These IAs are “timely responsiveness” and “adequate resources” respectively. Moreover, four of the IAs located below the criterion of 3.350 have ten o more citations. These IAs are “collaborative decision making” (10), “team building and teamwork” (16), “adequate risk management” (15), and reward structure link to the success of the project” (11). None of the IAs included as part of the study as a result of the industry meeting were considered CSIA according to the criterion of 3.335.

Analysis of the Critical Success Attributes for Project Integration

From the analyses presented in this Chapter it is possible to conclude that all but two integration attributes (IAs) have some level of importance. Nonetheless, there are some attributes that are critical for the integration process, and that if a project intends to be integrated, it should allocate most of its resources on enhancing each of those critical success attributes for achieving project integration (CSIA).

The CSIAs can be analyzed from different perspectives. In this section the CSIA are analyzed first in regard to broad aspects that they have in common; second, in terms the project participants that should be involved to implement them; third, in terms of the project phases where they are relevant; and finally in terms to their differences and similarity in relation to the integrated project delivery (IPD) .

Broad Aspects Associated with the Critical Success Attributes for Achieving Project Integration

From the list of the 45 IAs four broad aspects are identified by the author. It is important to take into consideration that these aspects are determined solely based on the judgment of the author. The four broad aspects are: behavioral or relational issues, contractual issues, organizational issues, and technology issues. Each CSIA is related to one or more of these aspects. Table 29 shows the categorization of the CSIAs on these aspects. The categorization is based on the author's judgment.

Table 29- Critical success attributes and their relation with behavioral or relational issues, contractual issues, organizational issues and technology issues

Critical Success Attribute	Scale Value	Behavioral or Relational Issues	Contractual Issues	Organizational Issues	Technology Issues
Open and continuous communication	4.828				
Early involvement of key project participants	4.593				
Organization and project manager leadership	4.501				
Information share and exchange	4.384				
Trust	4.317				
Timely responsiveness	4.269				
Owner commitment	4.165				
Personal attitude and commitment	4.098				
Efficient coordination	4.085				
Adequate resources	4.043				
Top management support	4.010				
Atmosphere of mutual respect	4.000				
Clear responsibilities and accountability structure	3.964				
Early goal definition	3.919				
Knowledge share	3.881				
Common goals and objectives	3.731				
Team selection criteria	3.679				
Intensified planning	3.501				
Contracting structure that fosters collaboration	3.474				

From Table 29 it is possible to conclude that most of the CSIAs are related to behavioral or relational issues, and to organizational issues; while there are less CSIAs related to contractual issues and to technology issues. However there is not a clear differentiation on this relation according to the level of importance for the critical success attributes, based on the scale value for the complete group of respondents.

In terms of technology issues there are not many CSIAs that are related to it. In addition, the CSIAs that are related to technology issues, use technology as a tool to accomplish their purpose, however could be solved with other tools different to technology. For instance "information share and exchange" will not be accomplished if the behavioral issues, the contracting issues and the organizational issues are not sorted out first. The same happens to "efficient coordination"; it will not be accomplished until the organizational issues related are solved. One interesting aspect is that other attributes that are directly related to technology such as "appropriate use of technology" and "shared BIM" do not fall into the CSIAs list, indicating that probably respondents have the perception that the coordination is critical as well as the exchange of information; however the tools used to realized these are not as critical, and do not have to be technology oriented.

Team Members that should be Involved to Accomplish the Critical Success attributes for Achieving Project Integration

The team members that should be involved in order to accomplish each CSIA have been identified according to the author judgment. Table 30 presents the team members that should be involved to implement the different CSIA.

Table 30- Team members that should be involved to accomplish each critical success attribute

Critical Success Attribute	Scale Value	Owner	Architect	Engenieers or Specialty Consultants	General Contractor	Subcontractor or Supplier	Facility Manager
Open and continuous communication	4.828						
Early involvement of key project participants	4.593						
Organization and project manager leadership	4.501						
Information share and exchange	4.384						
Trust	4.317						
Timely responsiveness	4.269						
Owner commitment	4.165						
Personal attitude and commitment	4.098						
Efficient coordination	4.085						
Adequate resources	4.043						
Top management support	4.010						
Atmosphere of mutual respect	4.000						
Clear responsibilities and accountability structure	3.964						
Early goal definition	3.919						
Knowledge share	3.881						
Common goals and objectives	3.731						
Team selection criteria	3.679						
Intensified planning	3.501						
Contracting structure that fosters collaboration	3.474						

When analyzing the team members that should be involved to accomplish each CSIA, it can be observed that all the team members should be involved in most of the attributes. However, owners are critical players in an integrated project because they have to be involved in all CSIAs if they are to be realized. The role of the architects and general contractors is also very important, as they are involved in many CSIAs; they are not involved just in the attributes that are exclusive of the owner, such as “owner commitment”, “early goal definition”, “team selection criteria” and “contracting structure”.

Critical Success Attributes for Achieving Project Integration across Project Phases

It is important to analyze the project phases when the CSIAs should be implemented and when those CSIAs can be more influential for achieving project integration. The categorization of CSIAs across project phases has been done according to the author judgment. Table 31 presents the critical success attributes across the project phases.

Table 31- Critical success attributes across project phases

Critical Success Attribute	Scale Value	Planning	Design	Construction	Operation and Maintenance
Open and continuous communication	4.828				
Early involvement of key project participants	4.593				
Organization and project manager leadership	4.501				
Information share and exchange	4.384				
Trust	4.317				
Timely responsiveness	4.269				
Owner commitment	4.165				
Personal attitude and commitment	4.098				
Efficient coordination	4.085				
Adequate resources	4.043				
Top management support	4.010				
Atmosphere of mutual respect	4.000				
Clear responsibilities and accountability structure	3.964				
Early goal definition	3.919				
Knowledge share	3.881				
Common goals and objectives	3.731				
Team selection criteria	3.679				
Intensified planning	3.501				
Contracting structure that fosters collaboration	3.474				

It is clear that a very important phase for project integration is planning as all the CSIAs are related to the planning phase. In addition it is very interesting see that most of the attributes are not phase specific but are actually attributes that should be realized across phases.

Critical Success Attributes and Integrated Project Delivery

It is important to point out that there are some CSIAs identified throughout this study are also included as principles or as part of the definition of the Integrated Project Delivery (IPD) developed by the AIA National and AIA California Chapter (2007), which is probably the most recognized approach to project integration currently in the

United Stated. However, there are several CSIAs that are not being currently explicitly considered by IPD under its principles or definitions addressed by IPD.

The CSIAs that are currently addressed in IPD are: “atmosphere of mutual respect”, “trust”, “early involvement of key project participants”, “intensified planning”, “early goal definition”, “owner commitment”, “open and continuous communication”, “organization and project manager leadership”, “information share and exchange”, and “contracting structure that fosters collaboration”. However other CSIAs, which are very important for achieving project integration according to the perceptions of respondents, are not included. These attributes are: “timely responsiveness”, “personal attitude and commitment”, “efficient coordination”, “adequate resources”, “top management support”, “clear responsibilities and accountability structure”, “knowledge share”, “common goals and objectives”, and “team selection criteria”.

In addition, there are some IAs that are considered as part of the IPD either as part of its principles or its definition that did not fall in the group of CSIAs, and that were located in the group of medium level of importance for achieving project integration. These IAs are: “internal conflict and dispute resolution”, “clear benefits for all”, “innovation and innovative thinking”, “collaborative decision making”, “reward structure linked to the success of the team”, “appropriate use of technology”, and “intensive involvement of a knowledgeable owner”.

On the other hand, it is interesting to notice that when the analysis was done by different roles, the architects identified as CSIAs more IAs that are part of the definition and principles of IPD, as compared to the CSIAs that were identified by the complete group of respondents. Those attributes are “collaborative decision making”, “innovation and innovative thinking", appropriate use of technology", "internal conflict and dispute resolution", and "intensive involvement of a knowledgeable owner". Possibly one explanation is that IPD was developed by the American Institute of Architects (AIA).

CHAPTER 9

RESULTS AND ANALYSIS: POTENTIAL IMPACT OF INTEGRATION ATRIBUTES ON PROJECT PERFORMANCE

In order to start investigating the potential impact of integration attributes on project performance, data from Part 2 of the survey was used. Respondents were asked to rate from 1 to 9 the impact of five randomly selected integration attributes (IAs) on each of the 12 project success or performance criteria (PPCs), where 1 was defined as no impact at all, and 9 as very high impact. Therefore for the purpose of this analysis, everything that falls below 4 is considered not to have an impact on PPCs, everything that falls around 5 is considered neutral in terms of PPCs impact, and everything above 6 represents different levels of impact. Two different analyses were used. First an analysis of the means was performed, and second a cluster analysis of IAs was completed based on their similarity across the average PPC measures. It is important to be aware that this is only a first step to start the discussion of the potential impact of project integration on project performance. However, it gives a solid starting point for future research.

Analysis of Means

In order to explore the potential impact of IAs on project performance, the mean rating of each IA's potential impact on each PPC was analyzed. The mean, standard deviation and standard error of the mean were calculated for the impact rating of each attribute on each performance criteria. The main objective of this analysis was to determine if there were some patterns in the behavior of the means across IAs. The list of means, standard deviations and plots of means for the potential impact of each IA on each PPC is presented on Appendix N.

Figure 41 presents the plot of the mean of each of IA for each of the 12 PPCs. The order of the attributes does not have any meaning; it is the order of the questions on the survey.

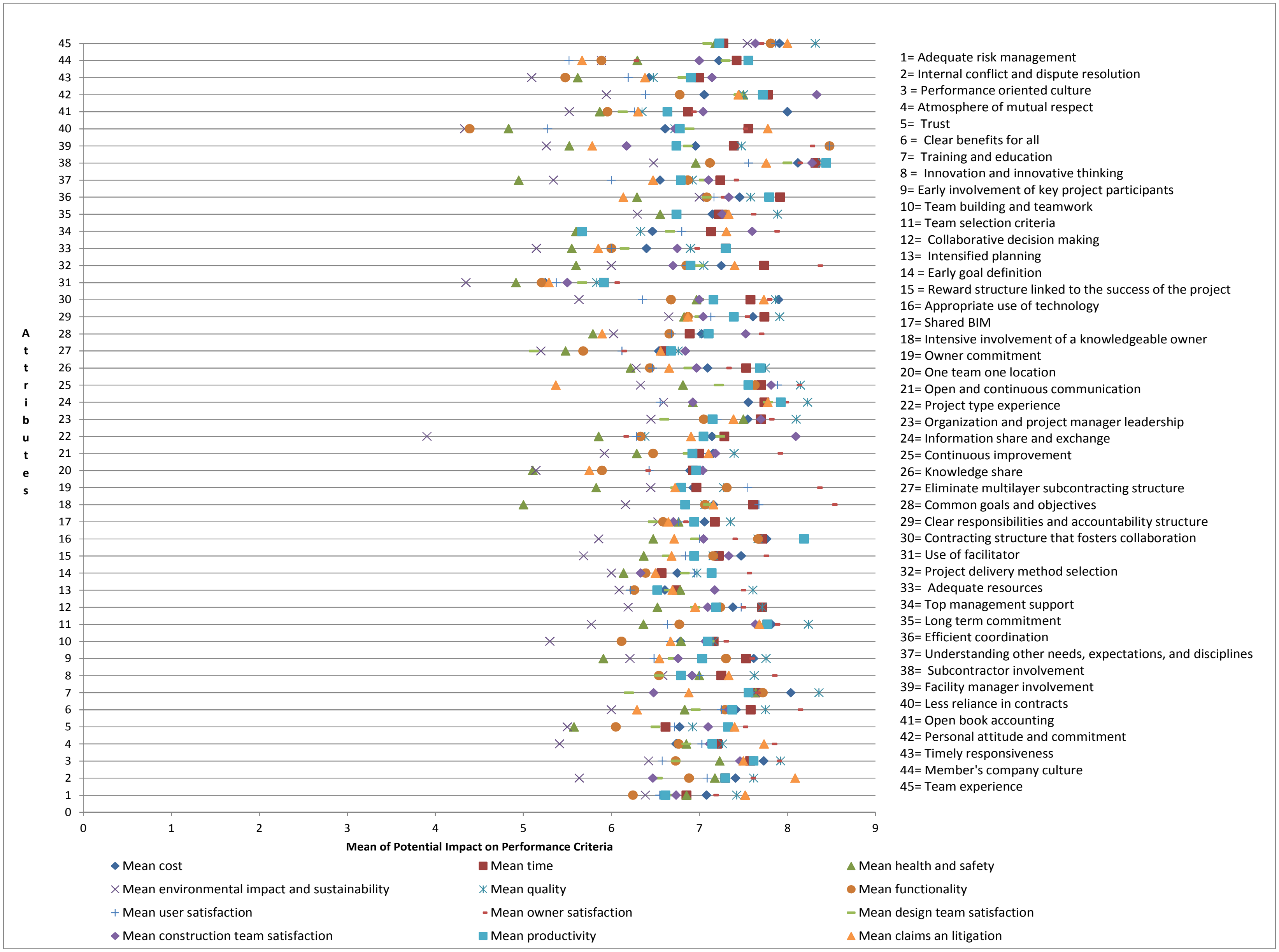

Figure 41- Mean of the potential impact of each of the integration attributes on each of the performance criteria

In Figure 41 patterns of behavior cannot be clearly detected; however, there are some interesting details to point out. On the 9 point rating scale, most of the means fall around 7, between 6 and 8, indicating that respondents have the perception that most integration attributes have some level of potential impact on most performance criteria. Nonetheless, there are some attributes that for some performance criteria are outliers of the group. There are attributes that for some performance criteria have a mean of eight or higher, indicating that according to the perception of respondents, these attributes seem to have a very high potential impact on those performance criteria; while there are some attributes that have a mean of 5 or lower, indicating that according to respondents' perception, these attributes seem to have little, if any, potential impact on those PPCs.

Table 32 summarizes the IAs that for a particular PPC have a mean of 8 or more than 8 and Table 33 presents the IAs that for a specific PPC have a mean of 5 or less than 5. For the purpose of the table Prod means Productivity, Qual means Quality, O sat mean Owner Satisfaction, Func means Functionality, U sat means User Satisfaction, H&S means Health and Safety, EI&S means Environmental Impact and Sustainability, C&L means Claims and Litigation, D sat means Design Team Satisfaction, and C sat means Construction Team Satisfaction.

Table 32- Summary of the attributes that have a mean >= 8 on a specific performance criterion

Attribute	Cost	Time	Prod	Qual	O sat	Func	U sat	H&S	E I &S	C&L	D Sat	C Sat
Internal conflict and dispute resolution												
Clear benefits for all												
Training and education												
Team selection criteria												
Appropriate use of technology												
Intensive involvement of a knowledgeable owner												
Owner commitment												
Project type experience												
Organization and project manager leadership												
Information share and exchange												
Continuous improvement												
Project delivery method selection												
Subcontractor involvement												
Facility manager involvement												
Personal attitude and commitment												
Team experience												

Table 33- Summary of the attributes that have a mean <=5 on a specific performance criterion

Attribute	Cost	Time	Prod	Qual	O sat	Func	U sat	H&S	E I &S	C&L	D Sat	C Sat
Project type experience												
Use of facilitator												
Understanding other needs and expectations												
Less reliance in contracts												

Cluster Analysis

As already stated it is difficult to identify many patterns by focusing on the analysis of means. Therefore a cluster analysis of the 45 IAs on the 12 PPCs was done. The main objective of this analysis was to illustrate the similarity of the IAs with respect to the mean potential impact rating across the 12 PPCs. Thus, each cluster groups the IAs that have greater similarity in regard to the mean rating for each of the 12 PPCs. The complete results of the cluster analysis are presented in Appendix O.

In order to determine the number of IAs clusters, three statistics from the table of cluster history are analyzed: the cubic clustering criterion, the pseudo-F and the pseudo-t^2. According to the cubic clustering criterion there is potentially one big cluster. The pseudo-F statistic suggests five clusters and the pseudo-t^2 suggests five clusters as well. Therefore five clusters were used for this analysis. The attributes assigned to each cluster in the hierarchical cluster analysis sequence is illustrated by the dendrogram presented in Figure 42.

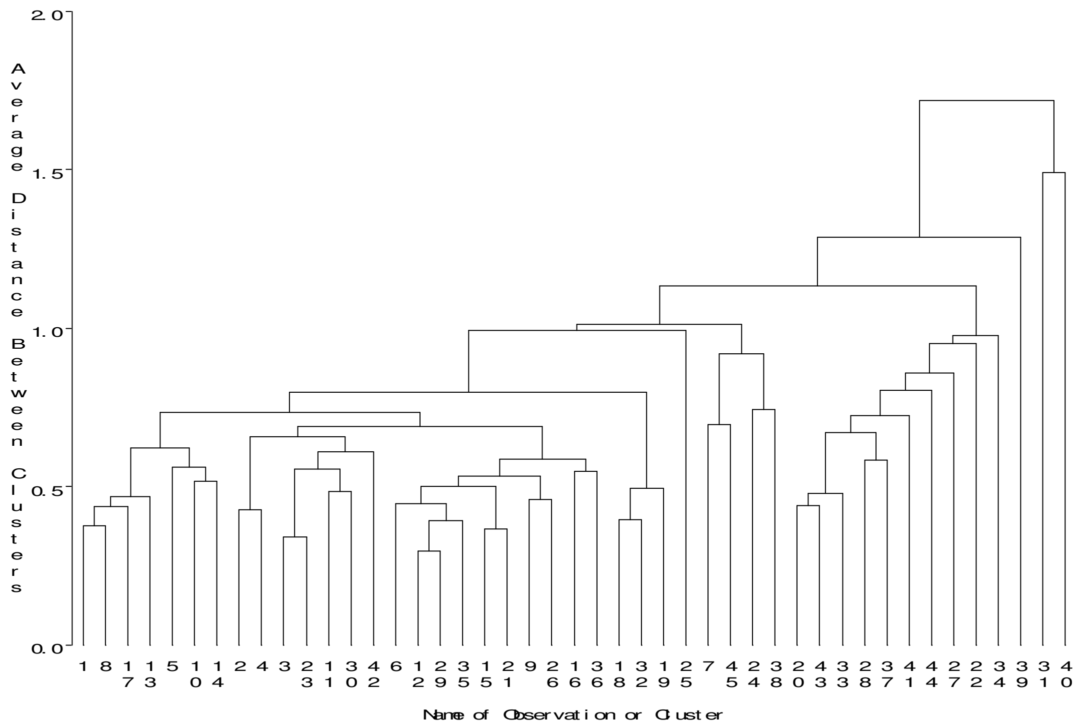

Figure 42- Dendrogram of the cluster analysis of the 45 IAs on the 12 PPCs

According to the dendrogram in Figure 42, cluster 1 is composed of 32 IAs, cluster 2 is composed of ten IAs, cluster 3 is composed of one IA, cluster 4 is composed of one IA, and cluster 5 is composed of one IA. The list of the attributes that fall in each cluster is shown in Table 34.

Table 34- List of attributes grouped in each cluster

Cluster Number	Attribute
1	Continuous improvement
1	Owner commitment
1	Project delivery method selection
1	Intensive involvement of a knowledgeable owner
1	Efficient coordination
1	Appropriate use of technology
1	Knowledge share
1	Early involvement of key project participants
1	Open and continuous communication
1	Reward structure linked to the success of the project
1	Long term commitment
1	Clear responsibilities and accountability structure
1	Collaborative decision making
1	Clear benefits for all
1	Personal attitudes and commitment
1	Contracting structure that fosters collaboration
1	Team selection criteria
1	Organization and project manager leadership
1	Performance oriented culture
1	Atmosphere of mutual respect
1	Internal conflict and dispute resolution
1	Early goal definition
1	Team building and team work
1	Trust
1	Intensified planning
1	Shared BIM
1	Innovation and innovative thinking
1	Adequate risk management
1	Subcontractor involvement
1	Information share and exchange
1	Team experience
1	Training and education
2	Top management support
2	Project type experience
2	Eliminate multilayer subcontracting structure
2	Member's company culture
2	Open book accounting
2	Understanding other needs, expectations, and disciplines
2	Common goals and objectives
2	Adequate resources
2	Timely responsiveness
2	One team one location
3	Facility manager involvement
4	Use of facilitator
5	Less reliance in contracts

Thus, IAs grouped in cluster 1 have a similar mean PPC ratings profiles. The same is true with IAs grouped in cluster 2. The IAs in cluster 3, cluster 4 and cluster 5 are IAs that have a mean PPC rating profile that substantially differ from the rest of the attributes.

To understand how the clusters behave respect to each of the PPCs, a plot of the mean of each cluster for each PPC is performed and is presented in Figure 43.

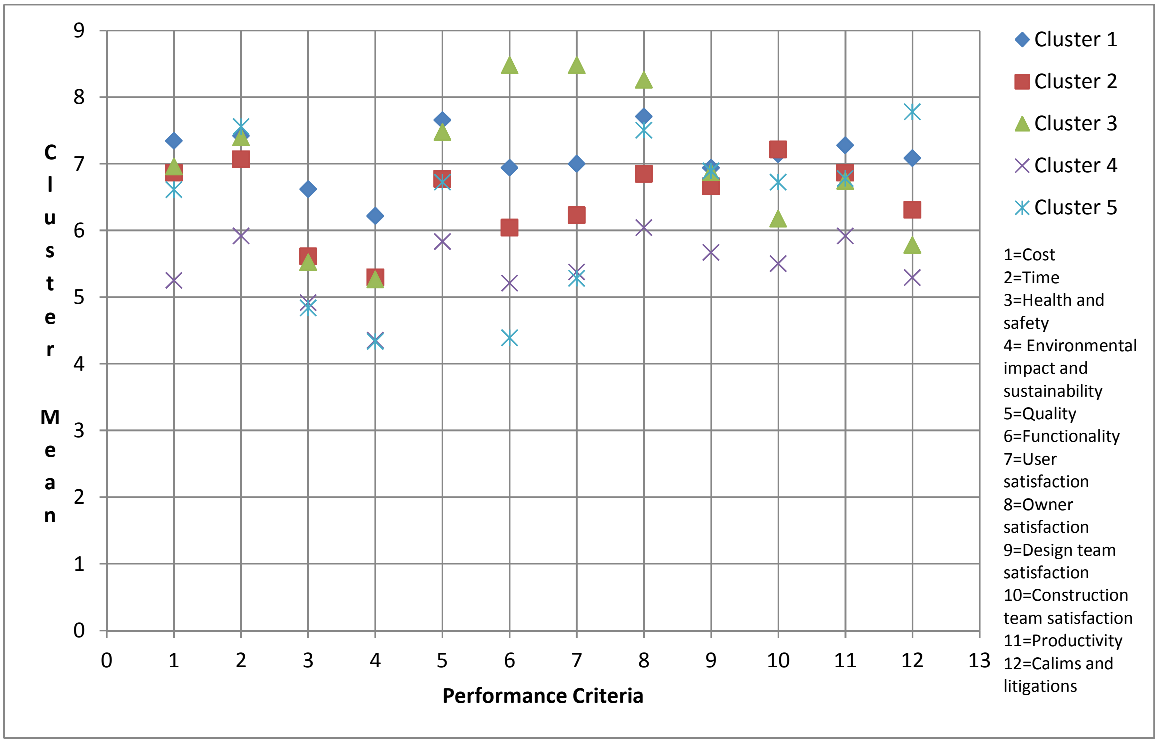

Figure 43- Plot of the mean of each cluster

Observing the plot of means for each of the clusters, it seems that for most of the PPCs the behavior of each of the clusters is different. For six PPCs, the highest mean is associated with cluster 1. These PPCs are Cost, Health and Safety, Environmental Impact and Sustainability, Quality, Design Team Satisfaction, and Productivity. For one PPC the highest mean is associated with Cluster 2, which is Construction Team Satisfaction. For three PPCs the highest mean is associated with cluster 3 (i.e., facility manager involvement); these PPCs are Owner Satisfaction, Functionality, and User Satisfaction.

There are no PPCs which highest means are associated with cluster 4 (i.e., use of facilitator). And finally, for two PPCs the highest means are associated with cluster 5 (i.e., less reliance in contracts); these PPCs are Claims and Litigation and Time.

On the other hand for most of the PPCs the lowest means are associated with cluster 4 (i.e., use of facilitator); however there are two PPCs that are User Satisfaction and Environmental Impact and Sustainability, where the lowest mean is associated with cluster 5 (i.e., less reliance in contracts).

In addition, it is interesting to note that to a large extent there are similarities among patterns of mean PPCs ratings across clusters for specific criteria. For instance there is similarity among Functionality and User Satisfaction that are more associated to the end product. There are also similarities on Cost performance, Time performance, and Productivity that are more associated with the construction phase of the project. And there are also some similarities on the impact on Quality and Owner Satisfaction that are related on how the owner perceives the project.

As the clusters 3, 4, and 5 are single attribute clusters, it is not possible to statistically test the differences observed in the mean of those clusters for each PPC. However, it is possible to statistically test the differences between the means of cluster 1 and cluster 2 for each PPC. A t-test was performed on the means of clusters 1 and 2 for each PPC with and alpha of 0.05. The p-values of the 12 tests are presented in Table 35. The complete results of the t-tests are presented in Appendix P. The table includes the means of the five clusters and the p-value of the t-tests between the means of cluster 1 and cluster 2 for each PPC. The PPCs are presented from the smallest p-value to the largest p-value.

Table 35- Means of each cluster and p-values for t-test between cluster 1 and cluster 2

Performance Criteria	Cluster Mean/Attribute Value					p-value t-test CL1 and CL2	Comment
	1	2	3	4	5		
Quality	7.66	6.77	7.48	5.83	6.72	<0.0001	Significant
Owner Satisfaction	7.71	6.85	8.26	6.04	7.50	<0.0001	Significant
Functionality	6.94	6.04	8.48	5.21	4.39	<0.0001	Significant
Health and Safery	6.62	5.61	5.52	4.92	4.83	<0.0001	Significant
User Satisfaction	7.00	6.23	8.48	5.38	5.28	<0.0001	Significant
Environmental Impact and Sustainability	6.22	5.29	5.26	4.35	4.33	<0.0001	Significant
Claims and Litigation	7.08	6.31	5.78	5.29	7.78	0.0008	Significant
Cost	7.34	6.87	6.96	5.25	6.61	0.0045	Significant
Time	7.42	7.07	7.39	5.92	7.56	0.0126	Significant
Productivity	7.27	6.86	6.74	5.92	6.78	0.02	Significant
Design Team Satisfaction	6.94	6.66	6.87	5.67	6.89	0.1106	Not Significant
Construction Team Satisfaction	7.14	7.21	6.17	5.50	6.72	0.6665	Not Significant

According to the results of the t-tests there are statistically significant differences between the means of cluster 1 and cluster 2 for ten PPCs. Therefore the means of IAs ratings in cluster 1 are higher than the means of IAs ratings in cluster 2 in the population for those 10 PPCs. Indicating that cluster 1 has higher potential impact than cluster 2 on the following PPCs: Quality, Owner Satisfaction, Functionality, Health and Safety, User Satisfaction, Environmental Impact and Sustainability, Claims and Litigation, Cost, Time, and Productivity.

On the other hand, there are two PPCs where no statistically significant differences were found between the means of cluster 1 and cluster 2. Therefore it is possible that in the population the means of IAs ratings in cluster 1 are equal to the means of IAs ratings in cluster 2 for those two PPCs. Indicating that it is possible that for the PPCs Design Team Satisfaction and Construction Team Satisfaction there are no differences on the potential impact of cluster 1 and cluster 2.

In order to visualize the results obtained and discussed and to easily associate the clusters with the attributes that form it, Table 36 and Table 37 were created. Both tables present the attributes that are grouped by each cluster and their potential impact on the different performance criteria according to the mean of the cluster. In order to visually portray the level of potential impact, two color schemes were used. In Table 36 the color scheme is based on green to red color scale, where greener colors represent higher levels of potential impact and redder colors represent lower levels of potential impact. On the other hand Table 37 has a gray scale color scheme, where darker colors represent higher levels of potential impact and lighter colors represent lower levels of potential impact, so blind color people can observe the differences. In addition, in both tables performance criteria were placed in order according to their possible associations. Thus, Functionality and User Satisfaction go together, Cost performance, Time performance and Productivity go together, Quality and Owner Satisfaction go together, and then the other performance criteria are presented with no specific order.

For the purpose of the table Prod means Productivity, Qual means Quality, O sat mean Owner Satisfaction, Func means Functionality, U sat means User Satisfaction, H&S means Health and Safety, EI&S means Environmental Impact and Sustainability, C&L means Claims and Litigation, D sat means Design Team Satisfaction, and C sat means Construction Team Satisfaction.

Table 36- List of attributes grouped in clusters and their potential impact on project performance criteria (lower potential impact higher potential impact)

Attribute	CL	Performance Criteria											
		Cost	Time	Prod	Qual	O sat	Func	U sat	H&S	E I &S	C&L	D Sat	C Sat
Continuous improvement	1												
Owner commitment													
Project delivery method selection													
Intensive involvement of a knowledgeable owner													
Efficient coordination													
Appropriate use of technology													
Knowledge share													
Early involvement of key project participants													
Open and continuous communication													
Reward structure linked to the success of the project													
Long term commitment													
Clear responsibilities and accountability structure													
Collaborative decision making													
Clear benefits for all													
Personal attitudes and commitment													
Contracting structure that fosters collaboration													
Team selection criteria													
organization and project manager leadership													
Performance oriented culture													
Atmosphere of mutual respect													
Internal conflict and dispute resolution													
Early goal definition													
Team building and team work													
Trust													
Intensified planning													
Shared BIM													
Innovation and innovative thinking													
Adequate risk management													
Subcontractor involvement													
Information share and exchange													
Team experience													
Training and education													
Top management support	2												
Project type experience													
Eliminate multilayer subcontracting structure													
Member's company culture													
Open book accounting													
Understanding other needs, expectations, and disciplines													
Common goals and objectives													
Adequate resources													
Timely responsiveness													
One team one location													
Facility manager involvement	3												
Use of facilitator	4												
Less reliance in contracts	5												

Table 37- List of attributes grouped in clusters and their potential impact on project performance criteria (lower potential impact → higher potential impact)

Attribute	CL	Performance Criteria											
		Cost	Time	Prod	Qual	O sat	Func	U sat	H&S	E I &S	C&L	D Sat	C Sat
Continuous improvement	1												
Owner commitment													
Project delivery method selection													
Intensive involvement of a knowledgeable owner													
Efficient coordination													
Appropriate use of technology													
Knowledge share													
Early involvement of key project participants													
Open and continuous communication													
Reward structure linked to the success of the project													
Long term commitment													
Clear responsibilities and accountability structure													
Collaborative decision making													
Clear benefits for all													
Personal attitudes and commitment													
Contracting structure that fosters collaboration													
Team selection criteria													
organization and project manager leadership													
Performance oriented culture													
Atmosphere of mutual respect													
Internal conflict and dispute resolution													
Early goal definition													
Team building and team work													
Trust													
Intensified planning													
Shared BIM													
Innovation and innovative thinking													
Adequate risk management													
Subcontractor involvement													
Information share and exchange													
Team experience													
Training and education													
Top management support	2												
Project type experience													
Eliminate multilayer subcontracting structure													
Member's company culture													
Open book accounting													
Understanding other needs, expectations, and disciplines													
Common goals and objectives													
Adequate resources													
Timely responsiveness													
One team one location													
Facility manager involvement	3												
Use of facilitator	4												
Less reliance in contracts	5												

In both tables it can be observed that most IAs have some level of potential impact on all different PPCs. However there are some PPCs that seem to be more influenced by most IAs than others. Cost, Time, Productivity, Quality, and Owner Satisfaction seem to be the PPCs where most IAs have the highest potential impact. Claims and Litigation, Design Team Satisfaction, and Construction Team Satisfaction seem to be PPCs where the potential impact of most IAs is lower than for the PPCs mentioned before. Functionality, User Satisfaction, Health and Safety and Environmental Impact and Sustainability seem to be the PPCs where most of the IAs have a lower potential impact in comparison to the PPCs mentioned before.

In addition, is apparent why the clusters that have just one IA were clustered separate from the rest of the IAs. Cluster 3 (i.e., facility manager involvement) had extreme values; it has very high potential impact on some PPCs such as Functionality, User Satisfaction, and Owner Satisfaction; while it has very low potential impact on other PPCs such as Health and Safety and Environmental Impact and Sustainability. The behavior of values associated with cluster 5 (i.e., less reliance in contracts) is similar to the behavior of cluster 3 as it also has extreme values on the potential impact on the PPCs; however, those extreme values are associated with different PPCs. Cluster 5 has a high potential impact on Time, Owner Satisfaction, and Claim and Litigation; while it seem to have a lower potential impact on Functionality, User Satisfaction, Health and Safety, and Environmental Impact and Sustainability. On the other hand, cluster 4 (i.e., use of facilitator) has a low potential impact on all PPCs.

CHAPTER 10

UNIFIED INTEGRATION FRAMEWORK

The main finding of this study is the identification of a set of critical success attributes for achieving project integration according to the perception of respondents, which to a large extent are the most important attributes for achieving project integration, for owners and facility managers, architects, engineers or specialty consultants, and general contractors and subcontractors. In addition, the different levels of importance for a broader set of attributes, which to different extents contribute to project integration, were obtained as well. Five broad levels of importance were identified.

The first level of importance is composed by attributes that according to the perception of the complete group of respondents are very important for achieving project integration; those attributes are considered to be the critical success attributes for achieving project integration by for the complete group of respondents because they have scale values above the criterion set for that scale. In other words they are the attributes that the complete group of respondents was expected to rate very highly, according to the successive intervals procedure.

The second level of importance is composed of attributes which according to the perception of respondents have a high impact on project integration. These are attributes which scale values are slightly below the criterion established for identifying critical success attributes for the complete sample, but are considered to be critical success attributes for two or more subsamples defined by occupational role.

The third level of importance is composed of attributes that according to the perception of respondents have a medium level of importance for achieving project integration. These are attributes which scale values are located between category boundary 3 (the category boundary that separates rating categories 6 and 7) and the criterion for critical success attributes for the complete group of respondents, and in addition are not critical success attributes for two or more roles.

The fourth level of importance is composed by attributes that according to the perception of respondents have a low importance for achieving project integration. These are attributes that for the complete group of respondents have a scale value that is very close to the category boundary 3, and that for any of the occupation segments is below category boundary 3, which are the attributes that respondents mostly rated 6 or below.

The fifth level of importance is composed of two attributes that according to the perception of respondents have a very low or neutral importance for achieving project integration. These attributes have scale values that are very close to category boundary 2 for the complete group of respondents, which is the category boundary located between ratings 5 and 6. In addition, they are attributes that for at least one occupation segment are located below category boundary 2, which are attributes that respondents mostly rated 5 or below. Moreover, these are attributes that according to the cluster analysis belong to a separate cluster in relation to the rest of the attributes.

To complement the main findings of this research a first step was made to start understanding the potential impact that integration has on predicted project performance, and how the impact is directly related to the attributes that are being considered and the different performance criteria that are being addressed. In this regard it was found that most of the integration attributes might have a positive impact on most performance criteria; however, it was not possible to establish a direct relationship between the level of importance for achieving project integration and the potential impact on performance criteria. The attributes are grouped in clusters according to their potential impact across all the performance criteria.

The findings of this study are summarized in Table 38 and Table 39. This summary is intended to be used as a framework to understand the different levels of importance of each of the integration attributes for achieving integration; in addition it presents the potential impact that those integration attributes have on each of the different performance criteria. The abbreviations and the color scheme used in Table 38 and Table 39 are the same used in Chapter 9, thus Prod means productivity, Qual means quality, O sat mean owner satisfaction, Func means functionality, U sat means user satisfaction, H&S means health and safety, EI&S means environmental impact and sustainability, C&L means claims and litigation, D sat means design team satisfaction, and C sat means construction team satisfaction. In addition in Table 38 the color scheme is based on green to red color scale, where greener colors represent higher levels of potential impact and redder colors represent lower levels of potential impact. On the other hand Table 39 has a gray scale, where darker colors represent higher levels of potential impact and lighter colors represent lower levels of potential impact, so blind color people can observe the differences. The definition of each of the attributes and the measurement proposed for each performance criteria are presented in Chapter 7.

Table 38- Unified project integration framework complemented with potential impact on performance (lower potential impact ▬ higher potential impact)

Integration Importance	Attribute	CL	Performace Criteria											
			Cost	Time	Prod	Qual	O sat	Func	U sat	H&S	E I &S	C&L	D Sat	C Sat
Critical Success Attributes: Very Important	Open and continuous communication	1												
	Early involvement of key project participants	1												
	Organization and project manager leadership	1												
	Information share and exchange	1												
	Trust	1												
	Timely responsiveness	2												
	Owner commitment	1												
	Personal attitudes and commitment	1												
	Efficient coordination	1												
	Adequate resources	2												
	Top management support	2												
	Atmosphere of mutual respect	1												
	Clear responsibilities and accountability structure	1												
	Early goal definition	1												
	Knowledge share	1												
	Common goals and objectives	2												
	Team selection criteria	1												
	Intensified planning	1												
	Contracting structure that fosters collaboration	1												
High Importance	Understanding other needs, expectations and disciplines	2												
	Internal conflict and dispute resolution	1												
	Subcontractor involvement	1												
	Intensive involvement of a knowledgeable owner	1												
	Performance oriented culture	1												
	Innovation and innovative thinking	1												
Medium Importance	Collaborative decision making	1												
	Team building and team work	1												
	Adequate risk management	1												
	Training and education	1												
	Appropriate use of technology	1												
	Team experience	1												
	Member's company culture	2												
	Facility manager involvement	3												
	Project delivery method selection	1												
	Continuous improvement	1												
	Long term commitment	1												
	Project type experience	2												
	Shared BIM	1												
	Clear benefits for all	1												
Low Importance	Reward structure linked to the success of the project	1												
	Eliminate multilayer subcontracting structure	2												
	Less reliance in contracts	5												
	Open book accounting	2												
Neutral	Use of facilitator	4												
	One team one location	2												

Table 39- Unified project integration framework complemented with potential impact on performance (lower potential impact ▭▭▭▭▭▭▭ higher potential impact)

Integration Importance	Attribute	CL	Cost	Time	Prod	Qual	O sat	Func	U sat	H&S	E I &S	C&L	D Sat	C Sat
Critical Success Attributes: Very Important	Open and continuous communication	1												
	Early involvement of key project participants	1												
	Organization and project manager leadership	1												
	Information share and exchange	1												
	Trust	1												
	Timely responsiveness	2												
	Owner commitment	1												
	Personal attitudes and commitment	1												
	Efficient coordination	1												
	Adequate resources	2												
	Top management support	2												
	Atmosphere of mutual respect	1												
	Clear responsibilities and accountability structure	1												
	Early goal definition	1												
	Knowledge share	1												
	Common goals and objectives	2												
	Team selection criteria	1												
	Intensified planning	1												
	Contracting structure that fosters collaboration	1												
High Importance	Understanding other needs, expectations and disciplines	2												
	Internal conflict and dispute resolution	1												
	Subcontractor involvement	1												
	Intensive involvement of a knowledgeable owner	1												
	Performance oriented culture	1												
	Innovation and innovative thinking	1												
Medium Importance	Collaborative decision making	1												
	Team building and team work	1												
	Adequate risk management	1												
	Training and education	1												
	Appropriate use of technology	1												
	Team experience	1												
	Member's company culture	2												
	Facility manager involvement	3												
	Project delivery method selection	1												
	Continuous improvement	1												
	Long term commitment	1												
	Project type experience	2												
	Shared BIM	1												
	Clear benefits for all	1												
Low Importance	Reward structure linked to the success of the project	1												
	Eliminate multilayer subcontracting structure	2												
	Less reliance in contracts	5												
	Open book accounting	2												
Neutral	Use of facilitator	4												
	One team one location	2												

This framework can be used by industry practitioners to determine where should they allocate their resources (e.g., money, time, people) if they want to have a more integrated project. In addition, it gives a first idea on how to allocate resources if they want to target a specific performance criterion. The part of this study that considers the potential impact on performance has to be further developed in order to be a decision making tool. In addition this framework can be used by educators to identify areas that should be part of their curriculum if they want to educate future professionals to better function in an integrated project environment. It is clear that personal skills and behavior are areas that need to be further developed in the education of architects, engineers, construction professionals and facility managers.

CHAPTER 11

FUTURE WORK

Several paths of research can be addressed in the future to complement the findings of this dissertation.

In terms of the importance of integration attributes for achieving project integration, four different areas of research can be addressed. First, it is important to conduct research aimed at validating the critical success attributes for achieving project integration, and to validate the different groups of attributes that were identified to have different levels of importance in the unified framework.

Second, it is important to conduct research for understanding the reasons behind the differences found among roles in terms of importance of the different attributes. It is especially important to understand why in some particular attributes there are significant differences, and why are there some attributes that are critical for one role or some roles and not for all the roles. Even though the differences are small and are attribute specific, it is important to further understand them, to determine if any attribute that has been placed in a lower level of importance by some roles and in a higher level of importance by other roles, may contribute to project integration or may not; however some roles placed them in a lower or higher level of importance because it goes against the interest or for the interest of one role, or because one role is more familiar or less familiar with it, or any other reason that may be behind.

Third, it is important to conduct research to quantitatively determine how the attributes relate to each other in terms of broader categories. For the purpose of analyzing the results of this study for major broader categories were determined based on the judgment of the researcher, and the critical success attributes were categorized on them. These categories were behavioral or relational issues, contractual issues, organizational issues, and technology issues. In addition based on the judgment of the researcher, the critical success attributes were categorized according to the phases of the project where they should be implemented and according to the team member that should be involved to implement it. It is important to validate these categories, and to validate the placement of the attributes in them, to further determine broader areas of action that team members and educator should focus to enhance project integration.

Fourth, it is important to conduct further research to understand the reasons behind the discrepancy between the critical success attributes for achieving project integration found in this study and the principles and definition of the Integrated Project Delivery (IPD), as this is probably the approach to project integration with greatest acceptance in the United States. One possible methodology could be to conduct a focus group or a workshop with industry experts to discuss findings of this study and to analyze with them the different issues that IPD is not currently considering that should be included, to understand why those issues are not being considered, and to define a roadmap for implementation.

In terms of the relationship between integration and project performance, this study explored the potential impact of integration attributes on performance; however this is an area that needs further research to be addressed. It would be important to conduct a study similar to the one presented, but where all the respondents rate the potential impact of all the attributes on all performance criteria, to implement a statistical analysis that can draw more conclusive results and to reduce the number of attributes and performance criteria that should be further validated. The finding obtained based on the perception of industry practitioners, should be validated, with data from real projects, where strategies to support the different attributes have been implemented, and performance criteria can be measured. In addition it would be important to further conduct research to assess if the level of importance of one attribute for project integration has any relationship with the level of impact of the same attribute on performance; since the main interest the industry has in project integration is related to its potential for improving project performance.

CHAPTER 12

CONCLUSIONS

According to the perception of respondents, most of the attributes under study have some level of importance for achieving project integration; however there are different levels of importance associated with different groups of attributes. The most important attributes for project integration, are categorized in this study as critical success attributes for achieving project integration. These attributes encompass the opinion of most of the different team players involved in a construction project. There are 19 critical success attributes for achieving project integration that are:

- open and continuous communication
- early involvement of key project participants
- organization and project manager leadership
- information share and exchange
- trust
- timely responsiveness
- owner commitment
- personal attitudes and commitment
- efficient coordination
- adequate resources
- top management support
- atmosphere of mutual respect
- clear responsibilities and accountability structure
- early goal definition
- knowledge share
- common goals and objectives

- team selection criteria
- intensified planning
- contracting structure that fosters collaboration

Most of these critical success attributes are more related to personal and behavioral issues, and to organizational issues, therefore these areas should receive a greater focus, not only at the project level, but also in research and education, if the integration of the project is a goal.

There is a second group of attributes that have a high level of importance, however are not critical for achieving project integration. These attributes are:

- understanding other’s needs, expectations and disciplines
- internal conflict and dispute resolution
- subcontractor involvement
- intensive involvement of a knowledgeable owner
- performance oriented culture
- innovation and innovative thinking

The third group of attributes has a medium level of importance in the process of achieving integration; it is composed:

- collaborative decision making
- team building and team work
- adequate risk management
- training and education
- appropriate use of technology
- team experience
- member's company culture
- facility manager involvement
- project delivery method selection

- continuous improvement
- long term commitment
- project type experience
- shared BIM
- clear benefits for all

And finally there is a fourth group of attributes that has a low level of importance for achieving project integration that is composed of the attributes:

- reward structure linked to the success of the project
- eliminate multilayer subcontracting structure
- less reliance in contracts
- open book accounting

On the other hand there are two attributes that were studied, but that might be neutral for project integration those are “use of facilitator” and “one team one location”; therefore if integration is a goal, less resources should be invested in these types of strategies.

There are some attributes that are somehow related; however they fall in different importance categories. For instance the attributes “information share and exchange”, and “knowledge share” are categorized as critical success attributes for project integration, while the attributes “shared BIM” and “appropriate use of technology”, are categorized in the medium importance category, the second two attributes are tools to support the first two attributes, therefore it is possible that sharing the knowledge and the information is critical for achieving project integration; while the tools used to do this exchange are less important and do not necessarily have to be technology oriented. Another example of attributes that are related, but fall in different categories are the attributes “owner commitment” that is considered to be a critical success attribute, and the attribute "intensive involvement of a knowledgeable owner" that is categorized as having high level of importance. This implies that the commitment of the owner as major decision maker is very important, while its constant involvement is less important for achieving project integration.

As previously stated, there are few attributes where differences were found with respect of the role of the respondent. One difference is in regard to the number of attributes considered critical for achieving project integration. The complete group considered 19 attributes, owners and facility managers considered 26 attributes, architects considered 29 attributes, engineers and specialty consultants considered 17 attributes, and general contractors and subcontractors considered 23 attributes as critical. However, most of the attributes especially in the upper portion of the scale are the same for most of the roles; therefore their responses are considered very homogeneous. Nevertheless, the most important differences were found in regard to the following attributes: "shared BIM" that was more important for the architects; "performance oriented culture" that was more important for owners and facility managers and architects; "involvement of a knowledgeable owner" that was more important for owners and facility managers and architects; "subcontractor involvement" that was more important for owners and facility managers, and for contractors and subcontractors; and "project delivery method selection" that was more important for contractors and general contractors.

Even though most of the attributes that have some level of importance for achieving project integration seem to have a considerable potential impact in most project performance criteria, it is not possible with the results of this study to establish a clear relationship between the level of importance of each attribute for achieving project integration, and the potential impact those attributes might have on each performance attributes. In addition, the potential impact of most of the integration attributes on each performance criteria varies depending on the performance criteria evaluated; therefore it is important to determine which performance criteria are being assessed before claiming that integration can help to enhance project performance.

Most of the integration attributes are divided in two groups according to how these attributes behave across all the performance criteria. Group 1 is composed of:

- open and continuous communication
- early involvement of key project participants
- organization and project manager leadership
- information share and exchange
- trust
- owner commitment
- personal attitudes and commitment
- efficient coordination
- atmosphere of mutual respect
- clear responsibilities and accountability structure
- early goal definition
- knowledge share
- team selection criteria
- intensified planning
- contracting structure that fosters collaboration
- internal conflict and dispute resolution
- collaborative decision making
- subcontractor involvement
- team building and team work

- intensive involvement of a knowledgeable owner
- adequate risk management
- performance oriented culture
- training and education
- appropriate use of technology
- innovation and innovative thinking
- team experience
- project delivery method selection
- continuous improvement
- long term commitment
- shared BIM
- clear benefits for all
- reward structure linked to the success of the project

Group 2 is composed of:

- timely responsiveness
- adequate resources
- top management support
- common goals and objectives
- understanding other’s needs, expectations and disciplines
- member's company culture
- project type experience
- eliminate multilayer subcontracting structure
- open book accounting
- one team one location

In addition there are three attributes that behave differently in comparison to the rest of the group and among them. These attributes are “facility manager involvement”, “use of facilitator”, and “less reliance in contracts”.

According to the respondents of this study the performance criteria that could be more potentially impacted by most integration attributes (those included in group 1 and group 2) are Cost, Time, Quality, Owner Satisfaction and Productivity; while the performance criteria that might be less affected by integration attributes are Health and Safety and Environmental Impact and Sustainability; however the potential impact on these two performance criteria of most of the attributes is not low either. In all of these performance criteria, the attributes in group 1 seem to have a higher potential impact than the attributes in group 2. In addition “facility manager involvement” seems to have a very high impact in User Satisfaction and in Functionality. “Less reliance in contracts” seems to have a higher impact in Claims and Litigation; while it seems to have a lesser impact on Functionality, User Satisfaction, Health and Safety, and Environmental Impact and Sustainability. Finally “use of facilitator” might have the lowest impact on all of the performance criteria.

The behavior of the groups and other attributes seems to be very similar, on performance criteria that are somehow related. For instance most of the attributes have a very similar behavior on Cost, Time, and Productivity, which are criteria more related to the construction phase of the project. In addition they have a similar behavior on Quality and Owner Satisfaction, which are criteria more related to the perception of the owner. Moreover, they have a similar behavior on User Satisfaction and Functionality, which are criteria more related to the end product. The results obtained on the potential impact of integration attributes on performance are very preliminary and high level and should be further developed in order to obtain conclusive results.

It is very important to take into consideration that all the findings of this study are based on the perception of industry practitioners; therefore it is possible the previous experience influence the perception of respondents.

The main contribution of this dissertation is the development of a unified framework for project integration that includes the perceptions of most of the construction project members. It helps to identify the critical success attributes for achieving project integration, and the different levels of importance of other attributes that are not critical for achieving project integration. In addition the framework is complemented with the potential impact that integration attributes might have on different project performance criteria according to the perception of respondents. This unified framework constitutes a contribution to the body of knowledge and to the body of practice. Because it can help practitioners and project decision makers to identify the strategies that should be implemented and how to allocate their resources on those strategies if an integrated project is to be attained. Moreover, it can help educators and trainers to identify areas where more focus should be exerted for the professionals they are educating to function better in an integrated project. In addition, it gives a solid starting point for the identification of the impact of integration on performance.

APPENDIX A

COMMENTS FROM PILOT SURVEY

Table 40- Comments from pilot survey

Subject Number	Comment
1	Time: 34 min
1	Overall instructions are clear
1	On the question regarding the assessment on performance criteria, I think if possible to attach the rating scale on the questions at the bottom of the screen to make the answers more accurate since the respondent would have to scroll up to be able to look at the rating.
1	The facility manager involvement definition is not clear. In the definition is it facility or facility manager?
1	To the best of your understanding please rate how important "subcontractor and supplier involvement" is to successfully achieve project integration: For the purpose of this study subcontractor and supplier involvement is defined as the involvement of subcontractors and suppliers as part of the project team key players early in the process as they are *the* ones who are actually performing the work on field.
1	For the purpose of this study open and continuous communication is defined *as* maintaining open and direct lines of communication between all project participants at all times, with no restrictions because of roles within the team.
1	To the best of your understanding please rate how important "intensified planning" is to successfully achieve project integration: For the purpose of this study intensified planning is defined as setting the project phases in a way that more time and effort is allocated to the planning phase and to other earlier phases because most of the analysis and decision making process should take place early, when there is greater opportunity for making more cost effective decisions with better financial impact. Early decisions are less costly and more effective. I am not sure if this sentence should be part of the definition. It might introduce bias since it is stating the benefits and not just the definition of intensified planning.
1	To the best of your understanding please rate how important "personal attitude and commitment" is to successfully achieve project integration: For the purpose of this study personal attitude and commitment is defined as the individual internal motivation to change *processes* and to improvement, including a change in attitude, mindset and commitment, by developing personal relationships with their counter parts and understand the motivations of the entire team. These changes are required from every person who is involved in the process at all levels, from the working-level people working at the jobsite on a daily basis to the top management.

Table 40-Continued

Subject Number	Comment
1	To the best of your understanding please rate how important "efficient coordination" is to successfully achieve project integration: For the purpose of this study efficient coordination is defined as the ability of the entire team of combining all project parts in a way that they do not present conflict. It can be achieved by sharing project information and by facilitating points of contact between the different parties. I am not sure if it should be efficient or effective. I think efficient is used when the amount of input is compared to the output. These are some definitions of efficacy or effectiveness that might help. Efficacy: getting things done, i.e. meeting targets. Effectiveness: doing "right" things, i.e. setting right targets to achieve an overall goal (the *effect*)
1	To the best of your understanding please rate how important "the use of a facilitator" is to successfully achieve project integration: For the purpose of this study use of facilitator is defined as having a who can help develop communication skills, foster~~s~~ respect and trust, guide the project team in the integration process, align~~s~~ individual goals and project goals, eliminate the fear of conflict, get commitment from the different stakeholders, make each party accountable for their responsibilities, and have leadership skills.
1	To the best of your understanding please rate how important "organization and project manager leadership" is to successfully achieve project integration: For the purpose of this study organization and project manager leadership is defined as the belief, attitude and commitment of the project manager and other leaders of the project towards integration in order to encourage it and to motivate the team. Encourage the team? You can change it to: ,,, in order to encourage and motivate the team.
1	In the question of types of agreement and contracting, there's an A missing in: to contract te*a*m members.
2	Time: 25 min
2	The survey questions page through which you would navigate, took longer than normal time to refresh
2	Definitions and their survey questions should be placed together, i.e. one after the other, so that respondents would not have to scroll up and down.
2	Titles (impact study) in the first set of slides should be different and distinguishable.
3	When i do an online questionnaire, i prefer to know where of the questionnaire i am, i mean it's better to have a completion bar on top of each page to show how many pages are left and how many page you have gone through
3	I know that your questionnaire have to be so long and in complete detail, but i don't think everyone would read it completely and would choose their real answers accurately. at the beginning was good but at the middle of it since the questions were too long and too much, i felt that i should just click next
3	In some pages when i would click "NEXT" it would go to another page that there wasn't any question and i had to click the "next" there again

Table 40-Continued

Subject Number	Comment
3	Once there was lots of questions just in one page!! in that case when you scroll down, you can easily pass some of the questions without answering them
3	Sometimes there was lots of explanations that i wanted to cry while reading them :D is there any way that you can shorten them???!!!
4	It took me 21 minutes to answer the survey, but I did not read every question fully. The repetition of "to the best of your knowledge..." made me read less of each question.
4	There are empty pages where one needs only click a button to advance to the next, it is confusing and one wonders if the site is working right or not
4	For the purpose of revising/piloting it would be nice to have page numbers or indexing of the questionnaire, i.e.: how many pages/sections total and the actual page/section you are at
4	On the "Risk management" definitions page the following phrase needs a little more clarification owner satisfaction is a subjective measure of how the owner feels when working on the project, how the project fulfills its expectations, and how likely is to work with the same team in future projects. The project fulfills whose expectations? Who is more likely to work with the same team? These are very minor issues, but better wording will make a better survey
4	Again, multiple questions in one page are not numbered and it is hard to gauge progress and go back to a question or return after doing another task. (Only by looking at which questions are answered can we return to the last unanswered question)
4	This question is incomplete and some tenses are not consistent: For the purpose of this study use of facilitator is defined as <u>having a who</u> can help develop communication skills, fosters respect and trust, guide the project team in the integration process, aligns individual goals and project goals, eliminate the fear of conflict, get commitment from the different stakeholders, make each party accountable for their responsibilities, and have leadership skills
5	Time: 26 min
5	Instructions were clear
5	Website was great, no problem at all
5	When you said team experience and defined it by both experince of the team and experience of the project type, the answer might not be the same for both, how the survey participants distinguish this?
5	Similar with training and education; training for skills or training for being a team?
5	subcontract/suplier involvement- this is imprortant but you add "early" in the definition, which might not be the case. Are you asking "early sc/suppl involv, or "just their involvement?

Table 40-Continued

Subject Number	Comment
5	When you said "intensive involvement of knowledgeable owner" maybe it is better to add and/or owner's rep.
5	there is a typo on the definition, the use of a facilitator" as having a ?
5	Team selection criteria "you mean the GC as a team, price or construction cost-overhead? Which term would be better...When you say price I was not so sure what you meant.
5	When you say "what is the primary role of your company" you are asking the role of the company and you give a list of roles for person-such as architect etc. this is kind of confusing.
5	I was not so sure of the definitions of "committment of the owner" and "open book accounting" OBA definition might be different as I remember
5	Sometimes you added a sentence to definitions starting with "because", which is not a definition but explanation. it might confuse people
5	Collaborative decision making, who is the final decision making? Also could be time consuming, but I think definition is not clear of what you mean.
5	"less reliance in contracts" I don't think this is practical since contracts are legally binding and not relying them might cause huge legal issues
5	Definition about BIM integration, when you say all team members, this might not be possible and might affect the answers, maybe you should say "As many team members as possible" or something like that
5	also for the last part, when you ask impact of ... with relation of others, definition listing and the choices are mixed, I think it would be better if you put the one that you are asking on top of the definition list- which you already did-and list the rest in alphabetical order and follow the same order with the choices
5	With every question, put a comma after the word study.
6	Time: 41 min
6	Instructions were clear. I would even say that they over-explain the different parts of the survey. I read all the instructions even when I knew I was doing the survey regardless.
6	role of the company: I think “consultant” should different from “Engineering”. I browsed the proposed list looking for a quick “consultant” or “advisor” and did not find it.
6	“sector of your company”: does it refer to “sector of your company clients”?
6	“collaborative process” definition not clear
6	“facility manager involvement”: I associate “facility manager” to a finished project, fully built and running. So I am not sure if I understood correctly
6	“members’ company culture”. The definition is good, but the name really does not help. “company culture” really did not trigger my intuition about what you meant so I read more than once the definition
6	Not a single problem with the survey itself

Table 40-Continued

Subject Number	Comment
6	In the first part, I saw myself checking two and three times the name of the feature being rated and the definitions. By doing so, you lose a lot of time scrooling up and down. Ideally, I would keep the glossary as proposed, but additionally I would suggest to have the definition deploying automatically when you put the pointer on top of the name (at the line of the question, not at the glossary
7	Time: 20 min
7	Instructions too wordy. Some information seemed more pertinent to your methodology than what the survey taker needed to know
7	If I were an industry participant, i would have been more interested if I saw a mention that results would be shared with me later.
7	Definitions: Much, much too wordy, the repeated "to the best of your knowledge was unnecessary and slowed the process. Not sure if cleaning up wordiness would help the cause, but its worth a try. Consider other simplifications....
7	No significant issues with the website
7	I was tempted to stop taking the survey on at a number of points, since the information was cumbersome and too wordy.
8	Time: 24 min
8	In the definitions: the concept of "productivity", ¿is not part of "time performance"?;
8	In the question "if you are not familiar with building information modeling, please skip this question", it would be better to say "...please skip the next 2 questions"
8	¿Is it possible have a counter ? For instance, if there are 20 pages, then they could be labeled as 1/20; 2/20; 3/20, etc...?.
9	Time: 42 minutes
9	I think group of questions can be separated by pages, so we can see only a small number of questions by page and don't get lost.
9	In the bottom of the page, should be a bar indicating the percentage of the survey I answered already, so I can estimate the remaining time.
9	Question number is very necessary to not get lost.
9	And a "save" stage of the survey, if I need to continue it later.
9	Because I spent too much time re-reading the same introduction for every question, I think you could group the questions of the first part as follows: *"for the purpose of this study, we will ask you to rank how important are some concepts to achieve project integration. We will give you some definitions at the bottom of each question. Please answer by the best of your understanding"* (or similar, as an introduction). It will reduce enormously the time of taking the survey.
9	Not at All Important > I think it is "not important at all" (not sure though)
9	What is your company size in terms of gross annual income? Or better directly ask: what is your company gross annual income?
9	Not clear definitions: members' company culture, performance oriented culture, collaborative process

Table 40-Continued

Subject Number	Comment
9	Not clear definitions:"appropriate use of technology" extensive use of software product Technology or software products?
9	Not clear definitions: project delivery method selection (Examples needed)
9	Not clear definitions: subcontractor and supplier involvement (early?) is defined as the involvement of subcontractors and suppliers as part of the project team key players early
9	Not clear definition: building information modeling definition?
9	similar questions (as I understood) subcontractor and supplier involvement = early involvement of key project participants commitment of the owner" = "intensive involvement of a knowledgeable owner"
9	Clear, but too long For the purpose of this study continuous improvement
9	Here the definition and the evaluation part I think should go next to each other: Integrated agreement Single purpose entity Separate owner-architect and owner-general contractor agreement Other, please specify (this part should have a longer text field, just in case someone want to write a definition as you have)
9	This list should have the same order as definitions (alphabetically or whatever). Functionality User Satisfaction Health and Safety Environmental Impact and Sustainability Owner Satisfaction Time Performance Productivity Construction Team Satisfaction Design Team Satisfaction Claims and Litigation Quality Cost Performance
9	In the same list, it could be better if *definition* and *ranking* are together (as previous questions) than having to go back and forth to read the definition….. Although…. You use the same definitions over and over, … maybe the section needs an introduction, so the user read the definitions just once…. But they should have a reminder at the bottom just in case…

Table 40-Continued

Subject Number	Comment
9	I also think that the concept to evaluate is kind of “lost” surrounded by so much text
9	“Please click on the "next" button to continue” is too frequently. It is every other page.
9	Maybe you can have less levels of evaluation than 1 to 9, so it could be easier for the user to discriminate the difference between 5 and 6 for example… But you know statistics better than me :)
9	No technical problems at all
10	Time: 23 min
10	Instructions are very clear, the definitions are very clear and the respondent has all the information required to answer the questions
10	Is it possible to include a progress bar? Or let the respondent know how long he has left?
11	Time: 54 min
11	Clarity of instructions: put definitions at bottom of page (with a note about it in the instructions). I was not sure if the definitions would be there, so I started reading through all of them – wasting time. All while the ratings were on the same page. I thought I would have to press next to go to the ratings page.
11	For the purpose of this study three different types of agreements of contracting structure that fosters collaboration will be assessed: Integrated agreement, Single purpose entity, Separate owner-architect and owner-general contractor agreements. Which of these agreement types of contracting structure that fosters collaboration do you think is more appropriate to contract tem members in an integrated project
11	The order of the definitions did not make sense to me. Maybe put them in order of the rating questions. Or place the definitions under each rating question to ensure the voter is thinking about the same definition as you are.
11	“It is not putting different firms to work together as separate disciplines with different objectives.” – I know what you are saying, but doesn’t sound clear.
11	Definition of productivity – is this talking about only construction productivity?
11	Common Goals and Objectives: what is the difference between project member and individual.
11	use of facilitator definition missing a word.
11	“internal conflict and dispute resolution is defined as the use of joint problem and conflict solving strategies that look for mutually satisfactory solutions and that seek ~~for~~ alternatives for problematic issues.”
11	open and continuous communication – is missing the word “as”
11	facility manager involvement definition is missing the word “manager”.
11	Use of facilitator missing the word “person”
11	If you stop and want to restart, the system doesn’t let you save and resume from where you were…
11	how is the “commitment of owner” ratings different from page before?
11	Just kind of funny, in one question you ask how important freely exchanging ideas is not according to the role of the

Table 40-Continued

Subject Number	Comment
12	No comments
13	Time: 43 min
13	The instructions were clear to me.
13	I do personal prefer a grade scale from 1 to 5 , it´s easier to qualify , you don´t lose too much time choosing between 6 and 7 for instance.
13	I found only 3 definitions that from my point of view need more clarity: Share the building info model, Clear benefits for all the members involved (the definition should be a little more explicative) and the adequate risk management from my point of view do need more explanation To really understand the risks involved.
13	The web site did work perfect
13	A grade system from 1-5 is better from my point of view, more objective.
14	Time: 24 min
14	I didn't have any trouble with the survey
14	Isn't productivity part of the concept of time performance?
14	"if you are not familiar with building information modelling, please skip this question",it is clear that you don't need to answer the next two questions, it would be better to say "...please skip the next 2 questions"
14	Is it possible to have a progress bar? Or to see how many pages are left?
15	Time: 22 min
15	The instructions were clear. I did not have any problem with them.
15	The definitions were clear but sometimes I had to read the long definitions twice so that I did not get confused.
15	I did not encounter any problems with the website.
15	I actually think it was an interesting survey, focused on one topic and answered based on my experience in construction.

APPENDIX B

SURVEY RECRUITING MATERIAL, CONSENT FORM, AND IRB PROTOCOL

Recruiting e-mail
Construction Industry Practitioners:

We are researchers of the School of Building Construction at the Georgia Institute of Technology. We are conducting a study which main goal is to identify the importance of different attributes to achieve project integration and the potential impact of such attributes on project performance. We would like to kindly request your participation in a 25 minutes long survey. You are being contacted because of your relationship with the construction industry as practitioner.

Participation in this survey is strictly voluntary. No personal information is collected and all your responses will be kept confidential and will only be used for academic purposes. We appreciate you potential participation in the study and if you have any questions regarding the study feel free to contact me at Daniel.Castro-Lacouture@coa.gatech.edu.

Please feel free to pass this request to other practitioners of the construction industry.

To access the survey please click the following link

http://www.prism.gatech.edu/~aospina3/survey/

Consent Document for Enrolling Adult Participants in a Research Study

Georgia Institute of Technology
Project Title:
Investigators: Daniel Castro-Lacouture, Ph.D, Angelica Ospina-Alvarado
Protocol and Consent Title: Construction Project Integration 08/25/2010 v1
You are being asked to be a volunteer in a research study.
Purpose:
The purpose of this study is to determine the importance of different attributes to successfully achieve project integration and their potential impact on project performance. We expect to enroll 15000 people in this study.
Exclusion/Inclusion Criteria:
Participants in this study must work in the construction industry.
Procedures:
If you decide to be in this study, your part will involve answering one online survey. The time required to respond the survey is around 25 minutes. The survey will have three parts; the first one is a set of demographic questions. The second part will include rating questions where you will be asked to rate how important is each attribute to integration and there will be few additional question regarding the attributes. The third part will include rating questions where you will be asked to rate the potential impact of five attributes, randomly selected, on project

performance. Part two and part three can appear in different order. There will not be any information that links you and your responses, therefore your responses are confidential. You may stop at any time and for any reason. The total amount of time you will be answering the survey is no more than twenty five minutes. Remember, you may stop at any time.

Risks or Discomforts:

The risks involved are no greater than those involved in daily activities such as reading an online article.

Benefits:

We hope that what we learn will help the construction industry to reach a unified definition of project integration and to identify the possible associations that may exist between project integration and project performance.

Compensation to You:

There is no compensation for participation

Confidentiality:

The following procedures will be followed to keep your personal information confidential in this study: The data collected about you will be kept private to the extent allowed by law. To protect your privacy, your records will be kept under a code number rather than by name. Your records will be kept in locked files and only study staff will be allowed to look at them. Your name and any other fact that might point to you will not appear when results of this study are presented or published. Your privacy will be protected to the extent allowed by law. To make sure that this research is being carried out in the proper way, the Georgia Institute of Technology IRB may review study records. The Office of Human Research Protections and/or the Food and Drug Administration may also look over study records during required reviews.

You should be aware that the experiment is not being run from a 'secure' https server of the kind typically used to handle credit card transactions, so there is a small possibility that responses could be viewed by unauthorized third parties such as computer hackers. In general, the web page software will log as header lines the IP address of the machine you use to access this page, e.g.,102.403.506.807, but otherwise no other information will be stored unless you explicitly enter it.

Costs to You:

There are no costs to you, other than your time, for being in this study

In Case of Injury/Harm:

If you are injured as a result of being in this study, please contact Daniel Castro-Lacouture, Ph.D., at telephone (404) 385-6964. Neither the Principal Investigator nor Georgia Institute of Technology has made provision for payment of costs associated with any injury resulting from participation in this study.

Participant Rights:

Your participation in this study is voluntary. You do not have to be in this study if you don't want to be. You have the right to change your mind and leave the study at any time without giving any reason and without penalty. Any new information that may make you change your mind about being in this study will be given to you. You do not waive any of your legal rights by consenting to participate in this study.

Questions about the Study:

If you have any questions about the study, you may contact Dr. Daniel Castro-Lacouture at telephone (404) 385-6964 or Daniel.Castro-Lacouture@coa.gatech.edu.

Questions about Your Rights as a Research Participant:

If you have any questions about your rights as a research participant, you may contact
Ms. Melanie Clark, Georgia Institute of Technology
Office of Research Compliance, at (404) 894-6942.
By completing the online survey, you indicate your consent to be in the study.

Institutional Review Board Protocol

Protocol H10259 As Of: March 2, 2011 09:06 PM

Title: Construction Project Integration

Principal Investigator: Daniel Castro-Lacouture

Current Status: Approved

Admin Assigned: Melanie Clark

Last Activity: 08/31/2010 - Approved Consent Forms Stamped

Committee Assigned: Central IRB Committee #1

Original Approval Start: 08/31/2010

Review Type: Exempt Review

Current Approval Period: 08/31/2010 - Indefinite

Protocol Details | Related Submissions

Protocol Description:

The goal of this study is to identify the critical success attributes that define project integration and rank their importance in achieving integration. In addition, this study seeks to identify the potential impact of project integration on performance and other project success criteria. In order to achieve these goals a survey will be conducted. The sample of this survey will be construction industry practitioners, and masters and PhD students. They will be asked three different sets of questions, the first set is composed of demographic questions, the second set of questions is composed of rating questions that ask to rate the importance of each integration attribute to successfully achieve project integration and some few questions related to the integration attributes, and a third set of question that ask to rate the potential impact of five integration attributes, selected randomly, on 11 performance factors. Set two and set three will appear in different order. The lenght of the survey is approximately 25 minutes.

Department:

Arch - BC

Research Personnel:

Name	Role	Certification
Daniel Castro-Lacouture	PI	• Human Subjects Training Certification (Approved): July 7, 2010 - Indefinite
Angelica Maria Ospina Alvarado	Student	• Human Subjects Training Certification (Approved): February 6, 2008 - Indefinite
Javier Irizarry	Co-Investigator	• Human Subjects Training Certification (Approved): September 23, 2008 - Indefinite

Funding:

Type: Not Funded

Figure 44- IRB protocol page 1

Research Locations:

Short Name	Full Name
Arch Annex	Architecture Annex - ARCH ANNEX

Lay Summary

A * required * Human Subjects Training is a requirement for approval. Have you completed Human Subjects Training? PLEASE NOTE: YOU CAN SUBMIT THE IRB APPLICATION PRIOR TO COMPLETION OF THE TRAINING, HOWEVER, APPROVAL WILL NOT BE ISSUED UNTIL TRAINING HAS BEEN COMPLETED AND THE OFFICE OF RESEARCH COMPLIANCE HAS YOUR TRAINING ON FILE. If you have not completed training you will find instructions on how to do so here PLEASE SAVE YOUR APPLICATION BEFORE CLICKING ON THE LINK AS YOU WILL BE TAKEN OUT OF IRBWISE AND ANY INFORMATION YOU HAVE ENTERED WILL BE LOST IF YOU DO NOT SAVE IT BEFORE LEAVING.

yes

B Describe in lay terms the purpose of the research. State what you hope to learn or prove. This section should not include scientific methodology or language. It should be easily understood by a lay person who has little or no expertise in your area of research.

By asking construction practitioners about their thoughts about the importance of different aspects to reach integration and about the impact that the same aspects might have on the outcomes of the construction projects, we hope to figure out which of those factors are important to have a better project. We plan to ask these questions to different people in the industry.

C State the Inclusion/Exclusion Criteria. For example, a survey about attitudes regarding education outside of the United States might have these inclusion criteria: Only those persons who are 18 years of age and older and who have attended one full academic year of secondary education outside of the United States are eligible to participate. For a study comparing two sports drinks to be used by athletes, persons who seldom exercise, have heart disease or hypertension, or are above a certain age might be excluded from participation.

The participants of this study will be construction industry practitioners, including masters and PhD students.

Figure 45- IRB protocol page 2

3/2/2011 IRBWise

Review Type Requested:

Expedited Review

Review Categories Suggested:

Category	Description
Expedited - Category 7	Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies. (NOTE: Some research in this category may be exempt from the HHS regulations for the protection of human subjects. 45 CFR 46.101(b)(2) and (b)(3). This listing refers only to research that is not exempt.)

Human Subject Interaction:

Will the research involve direct interaction with subjects?

Yes

Number of Subjects for this Protocol

15000

Gender of Subjects for this Protocol

Both genders

Vulnerable Populations:

Group Names

Students or Trainees

Subjects

A Total number of subjects to be enrolled in the study. Include justification. For clinical protocols, it is important to scientifically justify the number of participants needed and to state a precise number to be enrolled. For non-clinical and minimal risk studies, participant numbers may be stated as a range, (i.e.: 100-500. We will mail surveys to 500 addresses and hope to have responses from 100 participants). If responses are received from more than 100 participants, you will not have over-enrolled. Web-enabled recruitment may result in far more responses than anticipated or needed. If the number of participants has been stated as a range (Up

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Figure 46- IRB protocol page 3

to 1000), over-enrollment is less likely. You should be prepared to shut down a web recruitment site immediately if responses exceed the number of approved participants. Over-enrollment must be reported to the IRB as a protocol violation or deviation, and it may be unethical to accept responses from participants whose data are not needed and will not be utilized.

The survey is going to be sent to the Construction Science Research Foundation mailing list, to Georgia Tech building construction, and other related fields, masters and PhD students, andt to other mailing lists of construiction industry professional association. We will send around 15000 surveys expecting to get around 1500 responses, that is what we need to have a statistical significant study.

B Expected number of subjects to be enrolled per year:

15000, the study will be conducted in less than one year.

C Expected number of years study will be active.

Less than one

D State the duration of subject participation. How many hours? Days? Over what period of weeks or months?

25 minutes

E Federal regulations require that non-pregnant women be included in research unless their exclusion can be scientifically justified. Are you including women who are not pregnant?

Yes

F If you marked OTHER above, please provide the justification for excluding non-pregnant women:

(No Answer Given)

G If you are excluding minors, please state the scientific justification below. For example, "This study of Alzheimer's patients excludes minors, as that population is not known to have the disease." Or, "This study will examine driving records of over-the-road truckers who drive at least 250,000 miles annually. That population does not include minors."

No minors. See justification below

This study exclude minors, because there is not expected to have minors within the construction industry practitioners and masters and PhD students.

H * required * Provide detail of steps to be taken to ensure additional protection of the

Figure 47- IRB protocol page 4

rights and welfare of the identified vulnerable population.

The participation of masters and PhD students is completely voluntary and confidential. The survey is not part of any classes and will be delivered to them through a mailing list, therefore there will be no identifiers to determine if the student participated or not.

Recruitment

A Describe in detail the recruitment plan. Who will be recruited and how? By recruitment ads, word of mouth, email? If by word of mouth, PROVIDE A BRIEF SCRIPT. The IRB does not expect the script to be followed verbatim; however, the recruitment language must be reviewed. If using flyers, email, advertisements, screen shots from websites, or other documents, submit copies with this protocol.

Our subjects will be recruited using e-mail. We are going to send a cover letter e-mail and a link to the survey to different professsional organizations, these organizations will send the e-mail to their mailing list, the same e-mail will be sent to Georgia Tech PhD and masters students mailing lists from related fields.

B Is a Georgia Tech Student Subject Pool being used? NOTE: Only the School of Psychology and the College of Management have formal Student Subject Pools. In order to recruit from among either group, advance arrangements must be made with the manager of that pool.

No

C Will subjects be compensated for participation? If yes, provide details of remuneration, i.e.: total amount of money for completion of study and prorated amounts if study is not completed. If compensation will be class credit, state number of hours of credit to be granted for completion of study, and include plans for prorating credit if study is not completed.

No compensation will be given to our participants.

Subjects Data

A Will the data contain any information that could personally link the subject to the research?

No

B If Social Security numbers or other identifiers will be collected, state how those will be kept confidential. How will they be stored? Where will the linking key or code be safeguarded? Who will have access?

Figure 48- IRB protocol page 5

3/2/2011 IRBWise

There will be no identifiers collected.

C Will data be reviewed by a Data Safety Monitoring Board? (DSMBs generally monitor results of clinical trials for trends or unanticipated adverse events. For example, if adverse events of a similar nature begin to occur, the DSMB will call this to the attention of the investigators. In extreme cases, the study may need to be modified or even halted).

No

HIPAA Questions

A * required * Does this research involve the collection of health information? (Health information includes physical or mental information regarding the diagnosis, treatment and/or prevention of physical or mental conditions of the type that is now, or could be in the future, covered by health insurance.)

No

B If applicable, please check all of the following that will be collected by this research:

(No Answer Given)

C If the proposed activity is for research in which subject authorization will not be obtained, please check the appropriate answer:

(No Answer Given)

Other Questions

A Does this research activity involve the collection of biological specimens?

No

B If prospective, please specify below:

N/A

C Will specimens be collected anonymously (no way to link sample with subject identity) or in an identifiable (i.e. coded) manner?

N/A

D Is genetic testing of these specimens proposed?

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Figure 49-IRB protocol page 6

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N/A

E Is export control review required? If yes, please go to http://www.export.gatech.edu/

N/A

F If research involves the use of biological specimens, has Institutional Biological Materials Safeguards Committee approval been obtained? For guidance, please consult the Office of Environmental Health & Safety at 404 / 894-6119.

N/A

G Is use of rDNA proposed? If yes, attach the Institutional Biosafety Committee letter of approval in the Document Upload section of this IRB application. If Institutional Biosafety Committee approval has not yet been secured, submit the IBC application, located at http://www.compliance.gatech.edu/IBC/documents/IBC_REGISTRATION.doc

N/A

H All supporting documentation for this application must be uploaded in IRBWISE. Documents may be uploaded in section VI below called 'Attach Documents'. Please indicate all of the following documents to be uploaded.

Recruitment materials (flyers, ads, etc.)
Surveys/Questionnaires
Consent form (if applicable, upload in section III.C. "Consent Procedures)

Keywords:

Keywords

Construction project integration, construction project performance

Informed Consent Procedures:

Name	Description	Approval Date
	Per 45CFR46.117(c) an IRB may waive the requirement for the investigator to obtain a signed consent form for some or all subjects if it finds either: (1) That the only record linking the subject and the research would be the consent document and the principal risk would be potential harm resulting from a breach of confidentiality. Each subject will be asked whether the subject wants documentation linking the subject with the research, and the	

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subject's wishes will govern; or

(2) That the research presents no more than minimal risk of harm to subjects and involves no procedures for which written consent is normally required outside of the research context

Waiver of Documentation of Consent	(2) That the research presents no more than minimal risk of harm to subjects and involves no procedures for which written consent is normally required outside of the research context ****Please note that this option requires a consent document without the signature section: In cases where the requirement of documentation is waived (e.g., use of an anonymous survey is proposed, telephone survey, or web-based survey), a consent document in Georgia Institute of Technology IRB-required format must still be used. However, the document is written in letter format (Dear Subject) and, rather than requiring subject signature to verify consent, the following text is used to end the letter: If you ____________________ (e.g., complete the attached survey, answer these few questions etc.), it means that you have read -- or have had read to you -- the information contained in this letter and would like to be a volunteer in this research study. Thank you, (Signatures of Investigators)	August 31, 2010

Informed Consent

A Type of consent to be obtained:

Waiver of documentation of consent. Please explain below. (Specific criteria must be met-- THIS SHOULD BE REQUESTED FOR EXAMPLE IN THE CASE OF A WEB-BASED CONSENT FORM OR IF OBTAINING ORAL CONSENT. PLEASE NOTE: A WAIVER OF DOCUMENTATION OF CONSENT DOES NOT MEAN THAT YOU ARE NOT OBTAINING CONSENT YOU ARE JUST NOT OBTAINING A SIGNED CONSENT FORM. IF YOU REQUEST A "WAIVER OF DOCUMENTATION OF CONSENT" YOU MUST STILL SUBMIT THE CONSENT FORM.

The survey will be web-based

B Does this research involve a web-based consent/survey? If so, describe the security measures taken to ensure confidentiality.

Yes, please list below:

We will use a survey software program that stores all the data collected on their own servers, and gives us just the data as a spreadsheet with no identification to any particular survey. Their servers are protected with generally available security technologies, including firewalls and data encryption. These technologies are designed to prevent unauthorized access.

C How and where will participants' permission be recorded? You might, for example,

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state that participants' signatures will be collected on the consent form during a discussion prior to the first experiment.

Permission will not be recorded, because the survey will be web-based

D If subjects are unable to give consent (e.g., children or mentally incompetent), describe how and by whom permission will be granted.

We are not going to have subjects who are not able to give consent.

E Is deception involved in this research? If so, please read the following and then provide your justification in the space below. By its very nature, deception in research violates the principles of voluntary and informed consent to participate in research. Therefore, deception is an extraordinary measure that is not normally permitted in human subjects research. When proposed, the deception must meet all the following criteria: Risks to subjects are no greater than minimal; the rights and welfare of subjects must not be adversely affected; deception is essential in order for the investigator to carry out the research and, at the earliest possible time, subjects must be informed of the nature of the deception, and given a reasonable opportunity to withdraw from participation and to have their data excluded. Other important issues to be considered when using deception are: A reasonable person would be willing to participate in the research if he or she knew the nature and procedures of the study. Any data collected during the deception may be used only with a subject's explicit approval, obtained after the subject has received full disclosure regarding the study. The proposed research is sound in theory and methodology. Anticipated findings will contribute significantly to the general body of knowledge. Vulnerable subjects (the cognitively impaired, children, or prisoners) are excluded from research involving deception. Provide justification for planned deception below.

No

Documents:

Document Title	Document Type	File Submission Date	Document Approval Date	Stamped Consent Forms
Survey Instrument (download)	Survey Instrument	August 23, 2010	August 31, 2010	
Recruiting Material (download)	Recruitment	August 23, 2010	August 31, 2010	
Consent Form (download)	Consent Form (view checklist)	August 25, 2010	August 31, 2010	Consent Form (download)

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Documents Uploaded as Answers to Questions:

note: Use link in question column to view full question and answer text.

Question Group	Question (Limited to 50 Characters)	Answer (Limited to 50 Characters)	Uploaded File	Document Upload Date

None

Supplemental Documents:

File Name	Submitted Date	Submitted By

None

Conflict of Interest

A Does any participating member, staff, students (or his/her spouse or dependant Students and employees) have any financial interest such as royalty, equity or any other payments (e.g. consulting, salary, etc...) in the sponsor or other entities having a financial interest in intellectual property, product, or service which is the subject of the proposed research?

No

B Does/will any equity interest exceed $10,000 in current value or exceed 1% of ownership interest?

No

C Does/will aggregate annual payments for royalty and other payments exceed $10,000?

No

D If yes, indicate whether your potential conflict of interest has been disclosed to the GTRC Office.

(No Answer Given)

Related Submissions | Protocol Details

Amendments:

No Amendments

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Continuing Reviews:

No Continuing Reviews

Study Closures:

No Study Closures

Protocol Deviations/Violations:

No Protocol Deviation/Violations

Safety Reports:

No Safety Reports

SAE's and Adverse Events:

No SAEs

Investigator Brochures:

No Investigator Brochures

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APPENDIX C

SURVEY

Demographics: This part of the survey consists of 7 demographic questions.

What is the primary role of your company in the industry?

- ○ Architect
- ○ Engineer or Specialty Consultant
- ○ Facility Manager
- ○ General Contractor
- ○ Owner
- ○ Subcontractor or Supplier
- ○ Other, please specify: ______________________

Where is the location of your company?

- ○ United States
- ○ Other, please specify: ______________________

What is your company gross annual income?

- ○ Less than $250,000
- ○ $250,000 - $1 million
- ○ $1 million – $5 million
- ○ $5 million – $25 million
- ○ $25 million - $50 million
- ○ $50 million - $250 million
- ○ $250 million - $5 billion
- ○ More than $5 billion

What is the major sector of your company?

- ○ Civil
- ○ Commercial
- ○ Industrial
- ○ Institutional
- ○ Residential
- ○ Other, please specify: ______________________

Have you personally worked in a construction project?

- ○ Yes
- ○ No

What position do/did you have in your current/last construction project?
(E.g. project manager, lead architect, estimator, superintendent, etc.)

How many years of experience do you have in the construction industry?

- ○ Less than 1
- ○ 1-5
- ○ 6-10
- ○ 11-15
- ○ 16-20
- ○ 21-25
- ○ 26-30
- ○ More than 30

Part 1 This part of the survey consists of 45 questions where you are asked to rank how important “some attributes" are to successfully achieve project integration. The definitions of each attribute will be given above each rating scale for your reference. Please rate the importance of each attribute to successfully achieve project integration to the best of your understanding. After responding the 45 questions there will be 6 follow up questions. Please click on the "next" button to begin this part

How important "team work experience" is to successfully achieve project integration:
For the purpose of this study team experience is defined as the experience of the team and each individual in project integration.

	Not at All Important								Very Important
	1	2	3	4	5	6	7	8	9
Team experience/ Integration	○	○	○	○	○	○	○	○	○

How important "members’ company culture" is to successfully achieve project integration:
For the purpose of this study members’ company culture is defined as an internal culture of collaboration and teamwork with other companies that each company should have.

	Not at All Important								Very Important
	1	2	3	4	5	6	7	8	9
member's company culture/ Integrat	○	○	○	○	○	○	○	○	○

How important "timely responsiveness" is to successfully achieve project integration:
For the purpose of this study timely responsiveness is defined as having in place a short response time for the inquiries that arise from different parties.

	Not at All Important								Very Important
	1	2	3	4	5	6	7	8	9
Timely responsiveness/ Integration	○	○	○	○	○	○	○	○	○

How important "personal attitude and commitment" is to successfully achieve project integration:
For the purpose of this study personal attitude and commitment is defined as the individual internal motivation to change processes and to improvement, including a change in attitude, mindset and commitment, by developing personal relationships with their counter parts and understand the motivations of the entire team. These changes are required from every person who is involved in the process at all levels, from the working-level people working at the jobsite on a daily basis to the top management.

	Not at All Important								Very Important
	1	2	3	4	5	6	7	8	9
Personal attitude and commitment/ Integration	○	○	○	○	○	○	○	○	○

How important "open book accounting" is to successfully achieve project integration:
For the purpose of this study open book accounting is defined as having in place a transparent financial structure where all expenses and costs are explicit to team members, helping on building trust between the team, reducing reliance on bidding and contracts themselves, and keeping all team members accountable for their participation in the project.

	Not at All Important								Very Important
	1	2	3	4	5	6	7	8	9
Open book accounting/ Integration	○	○	○	○	○	○	○	○	○

How important "less reliance in contracts" is to successfully achieve project integration:
For the purpose of this study less reliance in contracts is defined as the ability of the team to interact, collaborate and support the project beyond the contract requirements and constraints.

	Not at All Important								Very Important
	1	2	3	4	5	6	7	8	9
Less reliance in contracts/ Integration	○	○	○	○	○	○	○	○	○

How important "facility manager involvement" is to successfully achieve project integration:
For the purpose of this study facility manager involvement is defined as the involvement of the facility manager as part of the project team key players early in the process as they are ones who know the requirements of maintenance and operations as well as the expectations of final users.

	Not at All Important								Very Important
	1	2	3	4	5	6	7	8	9
Facility manager involvement/ Integration	○	○	○	○	○	○	○	○	○

How important "subcontractor and supplier involvement" is to successfully achieve project integration:
For the purpose of this study subcontractor and supplier involvement is defined as the involvement of subcontractors and suppliers as part of the project team key players early in the process as they are the ones who are actually performing the work on field.

	Not at All Important								Very Important
	1	2	3	4	5	6	7	8	9
Subcontractor supplier involvement/ Integration	○	○	○	○	○	○	○	○	○

How important "understanding of other parties' needs, expectations and disciplines" is to successfully achieve project integration:

For the purpose of this study understanding of other parties' needs, expectations and disciplines is defined as the ability of each party to understand the goals, objectives, mission, needs, technologies, finances and operations, and disciplines of other participants.

	Not at All Important								Very Important
	1	2	3	4	5	6	7	8	9
Understanding other parties' needs, expectations and disciplines	○	○	○	○	○	○	○	○	○

How important "efficient coordination" is to successfully achieve project integration:
For the purpose of this study efficient coordination is defined as the ability of the entire team of combining all project parts in a way that they do not present conflict. It can be achieved by sharing project information and by facilitating points of contact between the different parties.

	Not at All Important								Very Important
	1	2	3	4	5	6	7	8	9
Efficient coordination/ Integration	○	○	○	○	○	○	○	○	○

How important "long term commitment" is to successfully achieve project integration:
For the purpose of this study long term commitment is defined as the commitment of the different parties to work together in future work, thereby parties can balance the attainment of short term objectives with long-term goals; reducing the fear for opportunistic behavior, eliminating waste in the process, and improving projects by learning from experience.

	Not at All Important								Very Important
	1	2	3	4	5	6	7	8	9
long term commitment/ Integration	○	○	○	○	○	○	○	○	○

How important "support from top management" is to successfully achieve project integration:
For the purpose of this study support from top management is defined as the commitment and belief in an integrated process of top management from parent organization of team members, who formulate the strategy and the direction of business activities.

	Not at All Important								Very Important
	1	2	3	4	5	6	7	8	9
Support from top management/ Integration	○	○	○	○	○	○	○	○	○

How important "adequate resources" is to successfully achieve project integration:
For the purpose of this study adequate resources is defined as the availability of resources in terms of knowledge, technology, information, specific skills, capital and time when needed.

	Not at All Important								Very Important
	1	2	3	4	5	6	7	8	9
Adequate resources/ Integration	○	○	○	○	○	○	○	○	○

How important "project delivery method selection" is to successfully achieve project integration:
For the purpose of this study project delivery method selection is defined as the selection of the method that determines relationship and interactions between project members.

	Not at All Important								Very Important
	1	2	3	4	5	6	7	8	9
project delivery method selection/ Integration	○	○	○	○	○	○	○	○	○

How important "the use of a facilitator" is to successfully achieve project integration:
For the purpose of this study use of facilitator is defined as having a person who can help develop communication skills, foster respect and trust, guide the project team in the integration process, align individual goals and project goals, eliminate the fear of conflict, get commitment from the different stakeholders, make each party accountable for their responsibilities, and have leadership skills.

	Not at All Important								Very Important
	1	2	3	4	5	6	7	8	9
Use of facilitator/ Integration	○	○	○	○	○	○	○	○	○

How important "contracting structure that fosters collaboration" is to successfully achieve project integration:
For the purpose of this study contracting structure that fosters collaboration is defined as an agreement that sets how the different parties are going to interact in the project and who is responsible to whom, in a way that fosters collaboration and communication, integrating the efforts of the entire team.

	Not at All Important								Very Important
	1	2	3	4	5	6	7	8	9
Contracting structure that fosters collaboration/ Integration	○	○	○	○	○	○	○	○	○

How important "clear responsibilities and clear accountability structure" is to successfully achieve project integration:
For the purpose of this study clear responsibilities and clear accountability structure is defined as structure defined up front that explicitly states responsibilities within the project and how those responsibilities will be assessed as the project progresses.

	Not at All Important								Very Important
	1	2	3	4	5	6	7	8	9
Clear responsibilities and clear accountability structure/ Integration	○	○	○	○	○	○	○	○	○

How important "common goals and objectives" is to successfully achieve project integration:
For the purpose of this study common goals and objectives is defined as an alignment between project goals, stakeholders' goals and individual's goals.

	Not at All Important								Very Important
	1	2	3	4	5	6	7	8	9
Common goals and objectives/ Integration	○	○	○	○	○	○	○	○	○

How important "eliminate multilayer subcontracting structure" is to successfully achieve project integration:
For the purpose of this study eliminate multilayer subcontracting structure is defined as a structure where the general contractor or the project manager hires directly the subcontractor that is going to perform the work increasing the accountability of parties involved.

	Not at All Important								Very Important
	1	2	3	4	5	6	7	8	9
Eliminate multi-layer subcontracting structure/ Integration	○	○	○	○	○	○	○	○	○

How important "knowledge sharing" is to successfully achieve project integration:
For the purpose of this study knowledge sharing is defined as the exchange of talent and knowledge between team members by exchanging ideas and attacking problems simultaneously from different disciplines.

	Not at All Important								Very Important
	1	2	3	4	5	6	7	8	9
Knowledge sharing/ Integration	○	○	○	○	○	○	○	○	○

How important "continuous improvement" is to successfully achieve project integration:
For the purpose of this study continuous improvement is defined as the ability and capability to improve as the project progresses and after the project is over in order to generate knowledge and to transfer knowledge, therefore decisions should be evaluated at different stages of the project in an iterative process that helps those decisions reflect broad team knowledge and the understanding of all interactions, feedback should exist, lessons learned should be evaluated during the project and after it, and a post project evaluation should exists.

	Not at All Important								Very Important
	1	2	3	4	5	6	7	8	9
Continuous improvement/ Integration	○	○	○	○	○	○	○	○	○

How important "information share and exchange" is to successfully achieve project integration:
For the purpose of this study information share and exchange is defined as the open, quick, effective and free flow of information from one organization to the other and among team members.

Not at All Important Very Important
1 2 3 4 5 6 7 8 9

Information share and exchange/ Integration ○ ○ ○ ○ ○ ○ ○ ○ ○

How important "organization and project manager leadership" is to successfully achieve project integration:
For the purpose of this study organization and project manager leadership is defined as the belief, attitude and commitment of the project manager and other leaders of the project towards integration in order to encourage integration and to motivate the team.

Not at All Important Very Important
1 2 3 4 5 6 7 8 9

Organization and project manager leadership/ Integration ○ ○ ○ ○ ○ ○ ○ ○ ○

How important "project type experience" is to successfully achieve project integration:
For the purpose of this study project type experience is defined as the experience of the team and each individual with the type of project that is being developed.

Not at All Important Very Important
1 2 3 4 5 6 7 8 9

Project type experience/ Integration ○ ○ ○ ○ ○ ○ ○ ○ ○

How important "open and continuous communication" is to successfully achieve project integration:
For the purpose of this study open and continuous communication is defined as maintaining open and direct lines of communication between all project participants at all times, with no restrictions because of roles within the team.

Not at All Important Very Important
1 2 3 4 5 6 7 8 9

Open and continuous communication/ Integration ○ ○ ○ ○ ○ ○ ○ ○ ○

How important "one team one location" is to successfully achieve project integration:
For the purpose of this study one team one location is defined as setting a certain place where team members can move to work in a collaborative environment where communication is facilitated and skills and knowledge are combined in a group.

Not at All Important Very Important
1 2 3 4 5 6 7 8 9

One team one location, Integration ○ ○ ○ ○ ○ ○ ○ ○ ○

How important "commitment of the owner" is to successfully achieve project integration:
For the purpose of this study commitment of the owner is defined as the understanding and belief of the owner on the integrated project process and of its benefits; thereby demanding the change of the industry practitioners.

	Not at All Important								Very Important
	1	2	3	4	5	6	7	8	9
Commitment of the owner/ Integration	○	○	○	○	○	○	○	○	○

How important "intensive involvement of a knowledgeable owner" is to successfully achieve project integration:
For the purpose of this study intensive involvement of a knowledgeable owner is defined as the active role the owner should have during the design and construction, because when the owner is involved, regular feedback exists between the owner and the rest of the team.

	Not at All Important								Very Important
	1	2	3	4	5	6	7	8	9
Intensive involvement of a knowledgeable owner/ Integration	○	○	○	○	○	○	○	○	○

How important "shared building information model" is to successfully achieve project integration:
For the purpose of this study shared building information model is defined as the use of one building model that has the input of all team members and that can be used by all team members. Note: If you are not familiar with building information modeling, please skip this question.

	Not at All Important								Very Important
	1	2	3	4	5	6	7	8	9
Shared building information model/ Integration	○	○	○	○	○	○	○	○	○

How important "appropriate use of technology" is to successfully achieve project integration:
For the purpose of this study appropriate use of technology is defined as the extensive use of software products to integrate the project phases, the project process, to exchange information and to improve communication.

	Not at All Important								Very Important
	1	2	3	4	5	6	7	8	9
Appropriate use of technology/ Integration	○	○	○	○	○	○	○	○	○

How important "reward structure linked to the success of the project" is to successfully achieve project integration:
For the purpose of this study reward structure linked to the success of the project is defined as a payment or reward structure that links the financial success of each project member to the success of the project, because it is essential for each party to recognize that they are going to succeed if the performance of other team members is successful and that they are not going to be penalized for bringing more efficient solutions to the project.

	Not at All Important								Very Important
	1	2	3	4	5	6	7	8	9
Reward structure linked to the success of the project/ Integration	○	○	○	○	○	○	○	○	○

How important "early goal and objectives definition" is to successfully achieve project integration:
For the purpose of this study early goal and objectives definition is defined as having in place a strategy to clearly set goals and objectives early in the process, and to help team members to understand them and to agree on them; because when goals are ambiguous for team members, the outcomes will not reflect what the project expects.

	Not at All Important								Very Important
	1	2	3	4	5	6	7	8	9
Early goal and objectives definition/ Integration	○	○	○	○	○	○	○	○	○

How important "intensified planning" is to successfully achieve project integration:
For the purpose of this study intensified planning is defined as setting the project phases in a way that more time and effort is allocated to the planning phase and to other earlier phases because most of the analysis and decision making process should take place early, when there is greater opportunity for making more cost effective decisions with better financial impact.

	Not at All Important								Very Important
	1	2	3	4	5	6	7	8	9
Intensified planing/ Integration	○	○	○	○	○	○	○	○	○

How important "collaborative decision making" is to successfully achieve project integration:
For the purpose of this study collaborative decision making is defined as a procedure of decision making based on the knowledge of the facts and points of view of the different team members to make the best decisions in the best interest of the project; therefore, ideas should be evaluated by the project team and consensus should be encouraged.

	Not at All Important								Very Important
	1	2	3	4	5	6	7	8	9
Collaborative decision making/ Integration	○	○	○	○	○	○	○	○	○

How important "team selection criteria and procedure" is to successfully achieve project integration:
For the purpose of this study team selection criteria and procedure is defined as a procedure of team selection not solely cost-based, but that includes other relevant criteria such as qualifications, previous experience, ability and commitment to participate in an integrated team, willingness to commit to shared-risk ideas, open communication and creation of a no-blame culture. Thereby price should be discussed after the team has been selected.

	Not at All Important								Very Important
	1	2	3	4	5	6	7	8	9
Team selection criteria and procedure/ Integration	○	○	○	○	○	○	○	○	○

How important "team-building and teamwork" is to successfully achieve project integration:
For the purpose of this study team-building and teamwork is defined as having in place strategies to encourage interdisciplinary groups where team members can contribute beyond their profession, by building relationships and trust among them. It is not putting different firms to work together as separate disciplines with different objectives.

	Not at All Important								Very Important
	1	2	3	4	5	6	7	8	9
Team-building and teamwork/ Integration	○	○	○	○	○	○	○	○	○

How important "early involvement of key project participants" is to successfully achieve project integration:
For the purpose of this study early involvement of key project participants is defined as bringing on board the most important project participants early in the process to improve the input of knowledge and expertise in the stages of the process when decisions are less costly and more effective.

	Not at All Important								Very Important
	1	2	3	4	5	6	7	8	9
Early involvement of key project participants/ Integration	○	○	○	○	○	○	○	○	○

How important "innovation and innovative thinking" is to successfully achieve project integration:
For the purpose of this study innovation and innovative thinking is defined as a process where ideas can be freely exchanged and are not evaluated according to the role of the person in the project; stimulating innovation and having an open mind to accept ideas from others to reach optimized solutions.

	Not at All Important								Very Important
	1	2	3	4	5	6	7	8	9
Innovation and innovative thinking/ Integration	○	○	○	○	○	○	○	○	○

How important "training and education" is to successfully achieve project integration:
For the purpose of this study training and education is defined as a desired characteristic of the people involved in the project, because team members should be trained and educated not only on the specific knowledge and skills of their trade, but also in the knowledge and skills of teamwork.

Not at All Important Very Important
1 2 3 4 5 6 7 8 9

Training and education/ Integration ○ ○ ○ ○ ○ ○ ○ ○ ○

How important "clear benefits for all members involved" is to successfully achieve project integration:
For the purpose of this study clear benefits for all members involved is defined as a process that has benefits that are clear upfront for all parties in the supply chain in line with the value they add to the process.

Not at All Important Very Important
1 2 3 4 5 6 7 8 9

Clear benefits for all members involved/ Integration ○ ○ ○ ○ ○ ○ ○ ○ ○

How important "trust" is to successfully achieve project integration:
For the purpose of this study trust is defined as the reliance of one party on another because expectations are met repeatedly and each party knows that others are reliable in fulfilling their obligations.

Not at All Important Very Important
1 2 3 4 5 6 7 8 9

Trust/ Integration ○ ○ ○ ○ ○ ○ ○ ○ ○

How important "atmosphere of mutual respect" is to successfully achieve project integration:
For the purpose of this study atmosphere of mutual respect is defined as a work environment characterized by ethical and honest behavior, with a no-blame culture, equitable relationships, and fairness.

Not at All Important Very Important
1 2 3 4 5 6 7 8 9

Atmosphere of mutual respect/ Integration ○ ○ ○ ○ ○ ○ ○ ○ ○

How important "performance oriented culture" is to successfully achieve project integration:
For the purpose of this study performance oriented culture is defined as setting performance of the project and performance of the team as important objectives that are continuously measured and assessed against clear targets.

Not at All Important Very Important
1 2 3 4 5 6 7 8 9

Performance oriented culture/ Integration ○ ○ ○ ○ ○ ○ ○ ○ ○

How important "internal conflict and dispute resolution" is to successfully achieve project integration:
For the purpose of this study internal conflict and dispute resolution is defined as the use of joint problem and conflict solving strategies that look for mutually satisfactory solutions and that seek alternatives for problematic issues.

	Not at All Important							Very Important
	1	2	3	4	5	6	7	8	9
Internal conflict and dispute resolution/ Integration	○	○	○	○	○	○	○	○	○

How important "adequate risk management" is to successfully achieve project integration:
For the purpose of this study adequate risk management is defined as the establishment of a risk sharing structure whose main goal should be to minimize the overall project risk instead of shifting the risk from one party to the other.

	Not at All Important							Very Important
	1	2	3	4	5	6	7	8	9
Adequate risk management/ Integration	○	○	○	○	○	○	○	○	○

Who do you think that the facilitator should be?
- ○ An external person who does not belong to any of the team members involved in the project
- ○ A person who belongs to one team member involved in the project

If you selected the option a person who belongs to one team members involved in the project, please specify the team member which should have this role:

For the purpose of this study three different types of agreements of contracting structure that fosters collaboration will be assessed: Integrated agreement, Single purpose entity, Separate owner-architect and owner-general contractor agreements. Which of these agreement types of contracting structure that fosters collaboration do you think is more appropriate to contract team members in an integrated project?

Integrated agreement: it is signed by the owner, the architect and the contractor as the core group. It clearly states the responsibilities of each party identifying the different members of the team. One objective is to align the interests of each party with the interests of the project. The team selection criteria are based on a request for proposals based on quality and value, instead of lowest price. The core group selects the other project participants and invites them to join or leave the team through a joining agreement.
Single purpose entity: it is formed by the owner, architect, construction manager, and other key project participants, its objective is to design and construct the project. It is a separate limited liability company from the members' organizations. The owner provides funding to the single purpose entity using one agreement and each non-owner members provides services to the single purpose entity using other agreement. The non-owner members get paid the costs of providing the specific service they provided to the project, and the profits are linked to achievement of project goals and shared savings provision. In order for one member to earn profit, all members must earn profit.
Separate owner-architect and owner-general contractor agreement: it is a structure composed of an owner-architect agreement and a guaranteed maximum price owner-

contractor agreement. It includes preconstruction services from the general contractor to work with the designers during the design phase. It does not set the duties of the owner, architect and contractor in separate silos, it it integrates the duties of each participant with the activities of the other two for each phase of the project.

- ○ Integrated agreement
- ○ Single purpose entity
- ○ Separate owner-architect and owner-general contractor agreement
- ○ Other, please specify: ______________________

Do you think that in order to be effective for project integration, building information modeling should be used in conjunction with other tools such as collaboration software and integrated web-based applications?
Note: If you are not familiar with building information modeling, please skip the next two questions.

- ○ Yes
- ○ No

To the best of your knowledge please rate how effective building information modeling is as a tool to improve scheduling and estimating?

	Not at All Effective 1	2	3	4	5	6	7	8	Very Effective 9
Building information model/ Scheduling and estimating	○	○	○	○	○	○	○	○	○

For the purpose of this study two methods of internal conflict and dispute resolution will be assessed, appointment of a decision making body and forced escalation of the conflict. Which of these methods of internal conflict and dispute resolution do you think is more appropriate to deal with problems at the project level?

Appointment of a decision making body for the entire team is a group of people composed of individuals from all parties, responsible for solving all conflicts.
Forced escalation of the conflict is based on a fixed time limit for each working level to solve a dispute or conflict. When this time expires with the dispute unsolved, it is raised one management level up until it gets to the chief executive officer (CEO) level of the organizations involved. The CEO level also has a time limit to solve the dispute before it goes to arbitration or mediation as final mechanisms.

- ○ Appointment of a decision making body
- ○ Forced escalation of the conflict

Part 2 This part of the survey consists of 5 pages where you are asked to rank the impact of 1 "attribute" on 11 performance criteria. Each page starts with a definition of the attribute and a glossary of the performance criteria for your reference. Please rate the impact of the attributes on the performance criteria to the best of your understanding. In between pages you will need to press the “next” button to continue to the next page, that will be randomly selected from a pool of pages. Please click on the "next" button to begin this part.

Impact of "adequate risk management" on each of the following performance criteria.
For the purpose of this study:
adequate risk management is defined as the establishment of a risk sharing structure whose main goal should be to minimize the overall project risk instead of shifting the risk from one party to the other.
claims and litigation is measured as economic damages resulting from claims and disputes.
construction team satisfaction is a subjective measure of how the construction team feels when working on the project and how the project fulfills its expectations.
cost performance is measured using the indicators of unit cost, percentage of cost variation relative to the budget, and net present value.
design team satisfaction is a subjective measure of how the design team feels when working on the project and how the project fulfills its expectations.
environmental impact and sustainability is measured using the criteria of the LEED certification or the ISO 14000 standard.
functionality is a subjective measure of how a project fulfills its intended function.
health and safety is measured using the indicator of number of accidents per number of man hours worked on a project
owner satisfaction is a subjective measure of how the owner feels when working on the project, how the project fulfills owner's expectations, and how likely the owner is to work with the same team in future projects.
productivity is a measure of output per unit of input, and is measured as the ratio of square footage per labor hour.
quality is a subjective measure defined as the achievement of features required to satisfy expectations of the owner, and is measured as the extent of meeting specifications.
time performance is measured using the indicators of construction time, speed of construction relative to square footage, and percentage of time variation relative to the schedule.
user satisfaction is a subjective measure of how a project satisfies the final user expectations.

	No Impact at All 1	2	3	4	5	6	7	8	Very High Impact 9
Cost Performance	○	○	○	○	○	○	○	○	○
Time Performance	○	○	○	○	○	○	○	○	○
Health and Safety	○	○	○	○	○	○	○	○	○

Environmental Impact and Sustainability	○	○	○	○	○	○	○	○	○
Quality	○	○	○	○	○	○	○	○	○
Functionality	○	○	○	○	○	○	○	○	○
User Satisfaction	○	○	○	○	○	○	○	○	○
Owner Satisfaction	○	○	○	○	○	○	○	○	○
Design Team Satisfaction	○	○	○	○	○	○	○	○	○
Construction Team Satisfaction	○	○	○	○	○	○	○	○	○
Productivity	○	○	○	○	○	○	○	○	○
Claims and Litigation	○	○	○	○	○	○	○	○	○

Impact of "internal conflict and dispute resolution" on each of the following performance criteria.
For the purpose of this study:
internal conflict and dispute resolution is defined as the use of joint problem and conflict solving strategies that look for mutually satisfactory solutions and that seek alternatives for problematic issues.
claims and litigation is measured as economic damages resulting from claims and disputes.
construction team satisfaction is a subjective measure of how the construction team feels when working on the project and how the project fulfills its expectations.
cost performance is measured using the indicators of unit cost, percentage of cost variation relative to the budget, and net present value.
design team satisfaction is a subjective measure of how the design team feels when working on the project and how the project fulfills its expectations.
environmental impact and sustainability is measured using the criteria of the LEED certification or the ISO 14000 standard.
functionality is a subjective measure of how a project fulfills its intended function.
health and safety is measured using the indicator of number of accidents per number of man hours worked on a project
owner satisfaction is a subjective measure of how the owner feels when working on the project, how the project fulfills owner's expectations, and how likely the owner is to work with the same team in future projects.
productivity is a measure of output per unit of input, and is measured as the ratio of square footage per labor hour.
quality is a subjective measure defined as the achievement of features required to satisfy expectations of the owner, and is measured as the extent of meeting specifications.
time performance is measured using the indicators of construction time, speed of construction relative to square footage, and percentage of time variation relative to the schedule.
user satisfaction is a subjective measure of how a project satisfies the final user expectations.

	No Impact at All								Very High Impact
	1	2	3	4	5	6	7	8	9
Cost Performance	○	○	○	○	○	○	○	○	○
Time Performance	○	○	○	○	○	○	○	○	○
Health and Safety	○	○	○	○	○	○	○	○	○
Environmental Impact and Sustainability	○	○	○	○	○	○	○	○	○
Quality	○	○	○	○	○	○	○	○	○
Functionality	○	○	○	○	○	○	○	○	○
User Satisfaction	○	○	○	○	○	○	○	○	○
Owner Satisfaction	○	○	○	○	○	○	○	○	○
Design Team Satisfaction	○	○	○	○	○	○	○	○	○
Construction Team Satisfaction	○	○	○	○	○	○	○	○	○
Productivity	○	○	○	○	○	○	○	○	○
Claims and Litigation	○	○	○	○	○	○	○	○	○

Impact of "performance oriented culture" on each of the following performance criteria.
For the purpose of this study:
performance oriented culture is defined as setting performance of the project and performance of the team as important objectives that are continuously measured and assessed against clear targets.
claims and litigation is measured as economic damages resulting from claims and disputes.
construction team satisfaction is a subjective measure of how the construction team feels when working on the project and how the project fulfills its expectations.
cost performance is measured using the indicators of unit cost, percentage of cost variation relative to the budget, and net present value.
design team satisfaction is a subjective measure of how the design team feels when working on the project and how the project fulfills its expectations.
environmental impact and sustainability is measured using the criteria of the LEED certification or the ISO 14000 standard.
functionality is a subjective measure of how a project fulfills its intended function.
health and safety is measured using the indicator of number of accidents per number of man hours worked on a project
owner satisfaction is a subjective measure of how the owner feels when working on the project, how the project fulfills owner's expectations, and how likely the owner is to work with the same team in future projects.
productivity is a measure of output per unit of input, and is measured as the ratio of square footage per labor hour.

quality is a subjective measure defined as the achievement of features required to satisfy expectations of the owner, and is measured as the extent of meeting specifications.
time performance is measured using the indicators of construction time, speed of construction relative to square footage, and percentage of time variation relative to the schedule.
user satisfaction is a subjective measure of how a project satisfies the final user expectations.

	No Impact at All 1	2	3	4	5	6	7	8	Very High Impact 9
Cost Performance	○	○	○	○	○	○	○	○	○
Time Performance	○	○	○	○	○	○	○	○	○
Health and Safety	○	○	○	○	○	○	○	○	○
Environmental Impact and Sustainability	○	○	○	○	○	○	○	○	○
Quality	○	○	○	○	○	○	○	○	○
Functionality	○	○	○	○	○	○	○	○	○
User Satisfaction	○	○	○	○	○	○	○	○	○
Owner Satisfaction	○	○	○	○	○	○	○	○	○
Design Team Satisfaction	○	○	○	○	○	○	○	○	○
Construction Team Satisfaction	○	○	○	○	○	○	○	○	○
Productivity	○	○	○	○	○	○	○	○	○
Claims and Litigation	○	○	○	○	○	○	○	○	○

Impact of "atmosphere of mutual respect" on each of the following performance criteria.
For the purpose of this study:
atmosphere of mutual respect is defined as a work environment characterized by ethical and honest behavior, with a no-blame culture, equitable relationships, and fairness.
claims and litigation is measured as economic damages resulting from claims and disputes.
construction team satisfaction is a subjective measure of how the construction team feels when working on the project and how the project fulfills its expectations.
cost performance is measured using the indicators of unit cost, percentage of cost variation relative to the budget, and net present value.
design team satisfaction is a subjective measure of how the design team feels when working on the project and how the project fulfills its expectations.
environmental impact and sustainability is measured using the criteria of the LEED certification or the ISO 14000 standard.

functionality is a subjective measure of how a project fulfills its intended function.
health and safety is measured using the indicator of number of accidents per number of man hours worked on a project
owner satisfaction is a subjective measure of how the owner feels when working on the project, how the project fulfills owner's expectations, and how likely the owner is to work with the same team in future projects.
productivity is a measure of output per unit of input, and is measured as the ratio of square footage per labor hour.
quality is a subjective measure defined as the achievement of features required to satisfy expectations of the owner, and is measured as the extent of meeting specifications.
time performance is measured using the indicators of construction time, speed of construction relative to square footage, and percentage of time variation relative to the schedule.
user satisfaction is a subjective measure of how a project satisfies the final user expectations.

	No Impact at All								Very High Impact
	1	2	3	4	5	6	7	8	9
Cost Performance	○	○	○	○	○	○	○	○	○
Time Performance	○	○	○	○	○	○	○	○	○
Health and Safety	○	○	○	○	○	○	○	○	○
Environmental Impact and Sustainability	○	○	○	○	○	○	○	○	○
Quality	○	○	○	○	○	○	○	○	○
Functionality	○	○	○	○	○	○	○	○	○
User Satisfaction	○	○	○	○	○	○	○	○	○
Owner Satisfaction	○	○	○	○	○	○	○	○	○
Design Team Satisfaction	○	○	○	○	○	○	○	○	○
Construction Team Satisfaction	○	○	○	○	○	○	○	○	○
Productivity	○	○	○	○	○	○	○	○	○
Claims and Litigation	○	○	○	○	○	○	○	○	○

Impact of "trust" on each of the following performance criteria.
For the purpose of this study:
trust is defined as the reliance of one party on another because expectations are met repeatedly and each party knows that others are reliable in fulfilling their obligations.
claims and litigation is measured as economic damages resulting from claims and disputes.
construction team satisfaction is a subjective measure of how the construction team feels when working on the project and how the project fulfills its expectations.

cost performance is measured using the indicators of unit cost, percentage of cost variation relative to the budget, and net present value.
design team satisfaction is a subjective measure of how the design team feels when working on the project and how the project fulfills its expectations.
environmental impact and sustainability is measured using the criteria of the LEED certification or the ISO 14000 standard.
functionality is a subjective measure of how a project fulfills its intended function.
health and safety is measured using the indicator of number of accidents per number of man hours worked on a project
owner satisfaction is a subjective measure of how the owner feels when working on the project, how the project fulfills owner's expectations, and how likely the owner is to work with the same team in future projects.
productivity is a measure of output per unit of input, and is measured as the ratio of square footage per labor hour.
quality is a subjective measure defined as the achievement of features required to satisfy expectations of the owner, and is measured as the extent of meeting specifications.
time performance is measured using the indicators of construction time, speed of construction relative to square footage, and percentage of time variation relative to the schedule.
user satisfaction is a subjective measure of how a project satisfies the final user expectations.

	No Impact at All 1	2	3	4	5	6	7	8	Very High Impact 9
Cost Performance	○	○	○	○	○	○	○	○	○
Time Performance	○	○	○	○	○	○	○	○	○
Health and Safety	○	○	○	○	○	○	○	○	○
Environmental Impact and Sustainability	○	○	○	○	○	○	○	○	○
Quality	○	○	○	○	○	○	○	○	○
Functionality	○	○	○	○	○	○	○	○	○
User Satisfaction	○	○	○	○	○	○	○	○	○
Owner Satisfaction	○	○	○	○	○	○	○	○	○
Design Team Satisfaction	○	○	○	○	○	○	○	○	○
Construction Team Satisfaction	○	○	○	○	○	○	○	○	○
Productivity	○	○	○	○	○	○	○	○	○
Claims and Litigation	○	○	○	○	○	○	○	○	○

Impact of "clear benefits for all members involved" on each of the following performance criteria.
For the purpose of this study:
clear benefits for all members involved is defined as a process that has benefits that are clear upfront for all parties in the supply chain in line with the value they add to the process.
claims and litigation is measured as economic damages resulting from claims and disputes.
construction team satisfaction is a subjective measure of how the construction team feels when working on the project and how the project fulfills its expectations.
cost performance is measured using the indicators of unit cost, percentage of cost variation relative to the budget, and net present value.
design team satisfaction is a subjective measure of how the design team feels when working on the project and how the project fulfills its expectations.
environmental impact and sustainability is measured using the criteria of the LEED certification or the ISO 14000 standard.
functionality is a subjective measure of how a project fulfills its intended function.
health and safety is measured using the indicator of number of accidents per number of man hours worked on a project
owner satisfaction is a subjective measure of how the owner feels when working on the project, how the project fulfills owner's expectations, and how likely the owner is to work with the same team in future projects.
productivity is a measure of output per unit of input, and is measured as the ratio of square footage per labor hour.
quality is a subjective measure defined as the achievement of features required to satisfy expectations of the owner, and is measured as the extent of meeting specifications.
time performance is measured using the indicators of construction time, speed of construction relative to square footage, and percentage of time variation relative to the schedule.
user satisfaction is a subjective measure of how a project satisfies the final user expectations.

	No Impact at All 1	2	3	4	5	6	7	8	Very High Impact 9
Cost Performance	○	○	○	○	○	○	○	○	○
Time Performance	○	○	○	○	○	○	○	○	○
Health and Safety	○	○	○	○	○	○	○	○	○
Environmental Impact and Sustainability	○	○	○	○	○	○	○	○	○
Quality	○	○	○	○	○	○	○	○	○
Functionality	○	○	○	○	○	○	○	○	○
User Satisfaction	○	○	○	○	○	○	○	○	○

Owner Satisfaction	○	○	○	○	○	○	○	○	○
Design Team Satisfaction	○	○	○	○	○	○	○	○	○
Construction Team Satisfaction	○	○	○	○	○	○	○	○	○
Productivity	○	○	○	○	○	○	○	○	○
Claims and Litigation	○	○	○	○	○	○	○	○	○

Impact of "training and education" on each of the following performance criteria.
For the purpose of this study:
training and education is defined as a desired characteristic of the people involved in the project, because team members should be trained and educated not only on the specific knowledge and skills of their trade, but also in the knowledge and skills of teamwork.
claims and litigation is measured as economic damages resulting from claims and disputes.
construction team satisfaction is a subjective measure of how the construction team feels when working on the project and how the project fulfills its expectations.
cost performance is measured using the indicators of unit cost, percentage of cost variation relative to the budget, and net present value.
design team satisfaction is a subjective measure of how the design team feels when working on the project and how the project fulfills its expectations.
environmental impact and sustainability is measured using the criteria of the LEED certification or the ISO 14000 standard.
functionality is a subjective measure of how a project fulfills its intended function.
health and safety is measured using the indicator of number of accidents per number of man hours worked on a project
owner satisfaction is a subjective measure of how the owner feels when working on the project, how the project fulfills owner's expectations, and how likely the owner is to work with the same team in future projects.
productivity is a measure of output per unit of input, and is measured as the ratio of square footage per labor hour.
quality is a subjective measure defined as the achievement of features required to satisfy expectations of the owner, and is measured as the extent of meeting specifications.
time performance is measured using the indicators of construction time, speed of construction relative to square footage, and percentage of time variation relative to the schedule.
user satisfaction is a subjective measure of how a project satisfies the final user expectations.

	No Impact at All								Very High Impact
	1	2	3	4	5	6	7	8	9
Cost Performance	○	○	○	○	○	○	○	○	○
Time Performance	○	○	○	○	○	○	○	○	○

Health and Safety	○	○	○	○	○	○	○	○	○
Environmental Impact and Sustainability	○	○	○	○	○	○	○	○	○
Quality	○	○	○	○	○	○	○	○	○
Functionality	○	○	○	○	○	○	○	○	○
User Satisfaction	○	○	○	○	○	○	○	○	○
Owner Satisfaction	○	○	○	○	○	○	○	○	○
Design Team Satisfaction	○	○	○	○	○	○	○	○	○
Construction Team Satisfaction	○	○	○	○	○	○	○	○	○
Productivity	○	○	○	○	○	○	○	○	○
Claims and Litigation	○	○	○	○	○	○	○	○	○

Impact of "innovation and innovative thinking" on each of the following performance criteria.
For the purpose of this study:
innovation and innovative thinking is defined as a process where ideas can be freely exchanged and are not evaluated according to the role of the person in the project; stimulating innovation and having an open mind to accept ideas from others to reach optimized solutions.
claims and litigation is measured as economic damages resulting from claims and disputes.
construction team satisfaction is a subjective measure of how the construction team feels when working on the project and how the project fulfills its expectations.
cost performance is measured using the indicators of unit cost, percentage of cost variation relative to the budget, and net present value.
design team satisfaction is a subjective measure of how the design team feels when working on the project and how the project fulfills its expectations.
environmental impact and sustainability is measured using the criteria of the LEED certification or the ISO 14000 standard.
functionality is a subjective measure of how a project fulfills its intended function.
health and safety is measured using the indicator of number of accidents per number of man hours worked on a project
owner satisfaction is a subjective measure of how the owner feels when working on the project, how the project fulfills owner's expectations, and how likely the owner is to work with the same team in future projects.
productivity is a measure of output per unit of input, and is measured as the ratio of square footage per labor hour.
quality is a subjective measure defined as the achievement of features required to satisfy expectations of the owner, and is measured as the extent of meeting specifications.

time performance is measured using the indicators of construction time, speed of construction relative to square footage, and percentage of time variation relative to the schedule.
user satisfaction is a subjective measure of how a project satisfies the final user expectations.

	No Impact at All								Very High Impact
	1	2	3	4	5	6	7	8	9
Cost Performance	○	○	○	○	○	○	○	○	○
Time Performance	○	○	○	○	○	○	○	○	○
Health and Safety	○	○	○	○	○	○	○	○	○
Environmental Impact and Sustainability	○	○	○	○	○	○	○	○	○
Quality	○	○	○	○	○	○	○	○	○
Functionality	○	○	○	○	○	○	○	○	○
User Satisfaction	○	○	○	○	○	○	○	○	○
Owner Satisfaction	○	○	○	○	○	○	○	○	○
Design Team Satisfaction	○	○	○	○	○	○	○	○	○
Construction Team Satisfaction	○	○	○	○	○	○	○	○	○
Productivity	○	○	○	○	○	○	○	○	○
Claims and Litigation	○	○	○	○	○	○	○	○	○

Impact of "early involvement of key project participants" on each of the following performance criteria.
For the purpose of this study: early involvement of key project participants is defined as bringing on board the most important project participants early in the process to improve the input of knowledge and expertise in the stages of the process when decisions are less costly and more effective. claims and litigation is measured as economic damages resulting from claims and disputes. construction team satisfaction is a subjective measure of how the construction team feels when working on the project and how the project fulfills its expectations. cost performance is measured using the indicators of unit cost, percentage of cost variation relative to the budget, and net present value. design team satisfaction is a subjective measure of how the design team feels when working on the project and how the project fulfills its expectations. environmental impact and sustainability is measured using the criteria of the LEED certification or the ISO 14000 standard. functionality is a subjective measure of how a project fulfills its intended function. health and safety is measured using the indicator of number of accidents per number of man hours worked on a project owner satisfaction is a subjective measure of how the owner feels when working on the project, how the project fulfills owner's expectations, and how likely the owner is to work with the same team in future projects. productivity is a measure of output per unit of input, and is measured

as the ratio of square footage per labor hour. quality is a subjective measure defined as the achievement of features required to satisfy expectations of the owner, and is measured as the extent of meeting specifications. time performance is measured using the indicators of construction time, speed of construction relative to square footage, and percentage of time variation relative to the schedule. user satisfaction is a subjective measure of how a project satisfies the final user expectations. No Impact at All Very High Impact

	1	2	3	4	5	6	7	8	9
Cost Performance	○	○	○	○	○	○	○	○	○
Time Performance	○	○	○	○	○	○	○	○	○
Health and Safety	○	○	○	○	○	○	○	○	○
Environmental Impact and Sustainability	○	○	○	○	○	○	○	○	○
Quality	○	○	○	○	○	○	○	○	○
Functionality	○	○	○	○	○	○	○	○	○
User Satisfaction	○	○	○	○	○	○	○	○	○
Owner Satisfaction	○	○	○	○	○	○	○	○	○
Design Team Satisfaction	○	○	○	○	○	○	○	○	○
Construction Team Satisfaction	○	○	○	○	○	○	○	○	○
Productivity	○	○	○	○	○	○	○	○	○
Claims and Litigation	○	○	○	○	○	○	○	○	○

Impact of "team-building and teamwork" on each of the following performance criteria. For the purpose of this study: team-building and teamwork is defined as having in place strategies to encourage interdisciplinary groups where team members can contribute beyond their profession, by building relationships and trust among them. It is not putting different firms to work together as separate disciplines with different objectives. claims and litigation is measured as economic damages resulting from claims and disputes. construction team satisfaction is a subjective measure of how the construction team feels when working on the project and how the project fulfills its expectations. cost performance is measured using the indicators of unit cost, percentage of cost variation relative to the budget, and net present value. design team satisfaction is a subjective measure of how the design team feels when working on the project and how the project fulfills its expectations. environmental impact and sustainability is measured using the criteria of the LEED certification or the ISO 14000 standard. functionality is a subjective measure of how a project fulfills its intended function. health and safety is measured using the indicator of number of accidents per number of man hours worked on a project owner satisfaction is a subjective measure of how the owner feels when working on the project, how the project fulfills owner's expectations, and how likely the owner is to work with the same team in future projects. productivity is a measure of output per unit of input, and is measured as the ratio of square footage per labor hour. quality is a subjective measure defined as the achievement of features required to satisfy expectations of the owner, and is measured as the extent of meeting specifications. time performance is measured using the indicators of construction time, speed of construction relative to square footage, and percentage of time variation relative to the schedule. user satisfaction is a subjective measure of how a project satisfies the final user expectations.

No Impact at All Very High Impact

	1	2	3	4	5	6	7	8	9
Cost Performance	○	○	○	○	○	○	○	○	○
Time Performance	○	○	○	○	○	○	○	○	○
Health and Safety	○	○	○	○	○	○	○	○	○
Environmental Impact and Sustainability	○	○	○	○	○	○	○	○	○
Quality	○	○	○	○	○	○	○	○	○
Functionality	○	○	○	○	○	○	○	○	○
User Satisfaction	○	○	○	○	○	○	○	○	○
Owner Satisfaction	○	○	○	○	○	○	○	○	○
Design Team Satisfaction	○	○	○	○	○	○	○	○	○
Construction Team Satisfaction	○	○	○	○	○	○	○	○	○
Productivity	○	○	○	○	○	○	○	○	○
Claims and Litigation	○	○	○	○	○	○	○	○	○

Impact of "team selection criteria and procedure" on each of the following performance criteria.
For the purpose of this study:
team selection criteria and procedure is defined as a procedure of team selection not solely cost-based, but that includes other relevant criteria such as qualifications, previous experience, ability and commitment to participate in an integrated team, willingness to commit to shared-risk ideas, open communication and creation of a no-blame culture. Thereby price should be discussed after the team has been selected.
claims and litigation is measured as economic damages resulting from claims and disputes.
construction team satisfaction is a subjective measure of how the construction team feels when working on the project and how the project fulfills its expectations.
cost performance is measured using the indicators of unit cost, percentage of cost variation relative to the budget, and net present value.
design team satisfaction is a subjective measure of how the design team feels when working on the project and how the project fulfills its expectations.

environmental impact and sustainability is measured using the criteria of the LEED certification or the ISO 14000 standard.
functionality is a subjective measure of how a project fulfills its intended function.
health and safety is measured using the indicator of number of accidents per number of man hours worked on a project
owner satisfaction is a subjective measure of how the owner feels when working on the project, how the project fulfills owner's expectations, and how likely the owner is to work with the same team in future projects.
productivity is a measure of output per unit of input, and is measured as the ratio of square footage per labor hour.
quality is a subjective measure defined as the achievement of features required to satisfy expectations of the owner, and is measured as the extent of meeting specifications.
time performance is measured using the indicators of construction time, speed of construction relative to square footage, and percentage of time variation relative to the schedule.
user satisfaction is a subjective measure of how a project satisfies the final user expectations.

	No Impact at All 1	2	3	4	5	6	7	8	9 Very High Impact
Cost Performance	○	○	○	○	○	○	○	○	○
Time Performance	○	○	○	○	○	○	○	○	○
Health and Safety	○	○	○	○	○	○	○	○	○
Environmental Impact and Sustainability	○	○	○	○	○	○	○	○	○
Quality	○	○	○	○	○	○	○	○	○
Functionality	○	○	○	○	○	○	○	○	○
User Satisfaction	○	○	○	○	○	○	○	○	○
Owner Satisfaction	○	○	○	○	○	○	○	○	○
Design Team Satisfaction	○	○	○	○	○	○	○	○	○
Construction Team Satisfaction	○	○	○	○	○	○	○	○	○
Productivity	○	○	○	○	○	○	○	○	○
Claims and Litigation	○	○	○	○	○	○	○	○	○

Impact of "collaborative decision making" on each of the following performance criteria. For the purpose of this study:
collaborative decision making is defined as a procedure of decision making based on the knowledge of the facts and points of view of the different team members to make the best decisions in the best interest of the project; therefore, ideas should be evaluated by the project team and consensus should be encouraged.

claims and litigation is measured as economic damages resulting from claims and disputes.
construction team satisfaction is a subjective measure of how the construction team feels when working on the project and how the project fulfills its expectations.
cost performance is measured using the indicators of unit cost, percentage of cost variation relative to the budget, and net present value.
design team satisfaction is a subjective measure of how the design team feels when working on the project and how the project fulfills its expectations.
environmental impact and sustainability is measured using the criteria of the LEED certification or the ISO 14000 standard.
functionality is a subjective measure of how a project fulfills its intended function.
health and safety is measured using the indicator of number of accidents per number of man hours worked on a project
owner satisfaction is a subjective measure of how the owner feels when working on the project, how the project fulfills owner's expectations, and how likely the owner is to work with the same team in future projects.
productivity is a measure of output per unit of input, and is measured as the ratio of square footage per labor hour.
quality is a subjective measure defined as the achievement of features required to satisfy expectations of the owner, and is measured as the extent of meeting specifications.
time performance is measured using the indicators of construction time, speed of construction relative to square footage, and percentage of time variation relative to the schedule.
user satisfaction is a subjective measure of how a project satisfies the final user expectations.

	No Impact at All 1	2	3	4	5	6	7	8	Very High Impact 9
Cost Performance	○	○	○	○	○	○	○	○	○
Time Performance	○	○	○	○	○	○	○	○	○
Health and Safety	○	○	○	○	○	○	○	○	○
Environmental Impact and Sustainability	○	○	○	○	○	○	○	○	○
Quality	○	○	○	○	○	○	○	○	○
Functionality	○	○	○	○	○	○	○	○	○
User Satisfaction	○	○	○	○	○	○	○	○	○
Owner Satisfaction	○	○	○	○	○	○	○	○	○
Design Team Satisfaction	○	○	○	○	○	○	○	○	○
Construction Team Satisfaction	○	○	○	○	○	○	○	○	○
Productivity	○	○	○	○	○	○	○	○	○

Claims and Litigation	○	○	○	○	○	○	○	○	○

Impact of "intensified planning" on each of the following performance criteria.
For the purpose of this study:
intensified planning is defined as setting the project phases in a way that more time and effort is allocated to the planning phase and to other earlier phases because most of the analysis and decision making process should take place early, when there is greater opportunity for making more cost effective decisions with better financial impact.
claims and litigation is measured as economic damages resulting from claims and disputes.
construction team satisfaction is a subjective measure of how the construction team feels when working on the project and how the project fulfills its expectations.
cost performance is measured using the indicators of unit cost, percentage of cost variation relative to the budget, and net present value.
design team satisfaction is a subjective measure of how the design team feels when working on the project and how the project fulfills its expectations.
environmental impact and sustainability is measured using the criteria of the LEED certification or the ISO 14000 standard.
functionality is a subjective measure of how a project fulfills its intended function.
health and safety is measured using the indicator of number of accidents per number of man hours worked on a project
owner satisfaction is a subjective measure of how the owner feels when working on the project, how the project fulfills owner's expectations, and how likely the owner is to work with the same team in future projects.
productivity is a measure of output per unit of input, and is measured as the ratio of square footage per labor hour.
quality is a subjective measure defined as the achievement of features required to satisfy expectations of the owner, and is measured as the extent of meeting specifications.
time performance is measured using the indicators of construction time, speed of construction relative to square footage, and percentage of time variation relative to the schedule.
user satisfaction is a subjective measure of how a project satisfies the final user expectations.

	No Impact at All 1	2	3	4	5	6	7	Very High Impact 8	9
Cost Performance	○	○	○	○	○	○	○	○	○
Time Performance	○	○	○	○	○	○	○	○	○
Health and Safety	○	○	○	○	○	○	○	○	○
Environmental Impact and Sustainability	○	○	○	○	○	○	○	○	○
Quality	○	○	○	○	○	○	○	○	○
Functionality	○	○	○	○	○	○	○	○	○

User Satisfaction	○	○	○	○	○	○	○	○	○
Owner Satisfaction	○	○	○	○	○	○	○	○	○
Design Team Satisfaction	○	○	○	○	○	○	○	○	○
Construction Team Satisfaction	○	○	○	○	○	○	○	○	○
Productivity	○	○	○	○	○	○	○	○	○
Claims and Litigation	○	○	○	○	○	○	○	○	○

Impact of "early goal and objectives definition" on each of the following performance criteria.
For the purpose of this study:
early goal and objectives definition is defined as having in place a strategy to clearly set goals and objectives early in the process, and to help team members to understand them and to agree on them; because when goals are ambiguous for team members, the outcomes will not reflect what the project expects.
claims and litigation is measured as economic damages resulting from claims and disputes.
construction team satisfaction is a subjective measure of how the construction team feels when working on the project and how the project fulfills its expectations.
cost performance is measured using the indicators of unit cost, percentage of cost variation relative to the budget, and net present value.
design team satisfaction is a subjective measure of how the design team feels when working on the project and how the project fulfills its expectations.
environmental impact and sustainability is measured using the criteria of the LEED certification or the ISO 14000 standard.
functionality is a subjective measure of how a project fulfills its intended function.
health and safety is measured using the indicator of number of accidents per number of man hours worked on a project
owner satisfaction is a subjective measure of how the owner feels when working on the project, how the project fulfills owner's expectations, and how likely the owner is to work with the same team in future projects.
productivity is a measure of output per unit of input, and is measured as the ratio of square footage per labor hour.
quality is a subjective measure defined as the achievement of features required to satisfy expectations of the owner, and is measured as the extent of meeting specifications.
time performance is measured using the indicators of construction time, speed of construction relative to square footage, and percentage of time variation relative to the schedule.
user satisfaction is a subjective measure of how a project satisfies the final user expectations.

	No Impact at All								Very High Impact
	1	2	3	4	5	6	7	8	9
Cost Performance	○	○	○	○	○	○	○	○	○
Time Performance	○	○	○	○	○	○	○	○	○
Health and Safety	○	○	○	○	○	○	○	○	○
Environmental Impact and Sustainability	○	○	○	○	○	○	○	○	○
Quality	○	○	○	○	○	○	○	○	○
Functionality	○	○	○	○	○	○	○	○	○
User Satisfaction	○	○	○	○	○	○	○	○	○
Owner Satisfaction	○	○	○	○	○	○	○	○	○
Design Team Satisfaction	○	○	○	○	○	○	○	○	○
Construction Team Satisfaction	○	○	○	○	○	○	○	○	○
Productivity	○	○	○	○	○	○	○	○	○
Claims and Litigation	○	○	○	○	○	○	○	○	○

Impact of "reward structure linked to the success of the project" on each of the following performance criteria.
For the purpose of this study:
reward structure linked to the success of the project is defined as a payment or reward structure that links the financial success of each project member to the success of the project, because it is essential for each party to recognize that they are going to succeed if the performance of other team members is successful and that they are not going to be penalized for bringing more efficient solutions to the project.
claims and litigation is measured as economic damages resulting from claims and disputes.
construction team satisfaction is a subjective measure of how the construction team feels when working on the project and how the project fulfills its expectations.
cost performance is measured using the indicators of unit cost, percentage of cost variation relative to the budget, and net present value.
design team satisfaction is a subjective measure of how the design team feels when working on the project and how the project fulfills its expectations.
environmental impact and sustainability is measured using the criteria of the LEED certification or the ISO 14000 standard.
functionality is a subjective measure of how a project fulfills its intended function.
health and safety is measured using the indicator of number of accidents per number of man hours worked on a project

owner satisfaction is a subjective measure of how the owner feels when working on the project, how the project fulfills owner's expectations, and how likely the owner is to work with the same team in future projects.
productivity is a measure of output per unit of input, and is measured as the ratio of square footage per labor hour.
quality is a subjective measure defined as the achievement of features required to satisfy expectations of the owner, and is measured as the extent of meeting specifications.
time performance is measured using the indicators of construction time, speed of construction relative to square footage, and percentage of time variation relative to the schedule.
user satisfaction is a subjective measure of how a project satisfies the final user expectations.

	No Impact at All 1	2	3	4	5	6	7	8	9 Very High Impact
Cost Performance	○	○	○	○	○	○	○	○	○
Time Performance	○	○	○	○	○	○	○	○	○
Health and Safety	○	○	○	○	○	○	○	○	○
Environmental Impact and Sustainability	○	○	○	○	○	○	○	○	○
Quality	○	○	○	○	○	○	○	○	○
Functionality	○	○	○	○	○	○	○	○	○
User Satisfaction	○	○	○	○	○	○	○	○	○
Owner Satisfaction	○	○	○	○	○	○	○	○	○
Design Team Satisfaction	○	○	○	○	○	○	○	○	○
Construction Team Satisfaction	○	○	○	○	○	○	○	○	○
Productivity	○	○	○	○	○	○	○	○	○
Claims and Litigation	○	○	○	○	○	○	○	○	○

Impact of "appropriate use of technology" on each of the following performance criteria.
For the purpose of this study:
appropriate use of technology is defined as the extensive use of software products to integrate the project phases, the project process, to exchange information and to improve communication.
claims and litigation is measured as economic damages resulting from claims and disputes.
construction team satisfaction is a subjective measure of how the construction team feels when working on the project and how the project fulfills its expectations.
cost performance is measured using the indicators of unit cost, percentage of cost variation relative to the budget, and net present value.
design team satisfaction is a subjective measure of how the design team feels when working on the project and how the project fulfills its expectations.
environmental impact and sustainability is measured using the criteria of the LEED certification or the ISO 14000 standard.
functionality is a subjective measure of how a project fulfills its intended function.
health and safety is measured using the indicator of number of accidents per number of man hours worked on a project
owner satisfaction is a subjective measure of how the owner feels when working on the project, how the project fulfills owner's expectations, and how likely the owner is to work with the same team in future projects.
productivity is a measure of output per unit of input, and is measured as the ratio of square footage per labor hour.
quality is a subjective measure defined as the achievement of features required to satisfy expectations of the owner, and is measured as the extent of meeting specifications.
time performance is measured using the indicators of construction time, speed of construction relative to square footage, and percentage of time variation relative to the schedule.
user satisfaction is a subjective measure of how a project satisfies the final user expectations.

	No Impact at All							Very High Impact	
	1	2	3	4	5	6	7	8	9
Cost Performance	○	○	○	○	○	○	○	○	○
Time Performance	○	○	○	○	○	○	○	○	○
Health and Safety	○	○	○	○	○	○	○	○	○
Environmental Impact and Sustainability	○	○	○	○	○	○	○	○	○
Quality	○	○	○	○	○	○	○	○	○
Functionality	○	○	○	○	○	○	○	○	○
User Satisfaction	○	○	○	○	○	○	○	○	○
Owner Satisfaction	○	○	○	○	○	○	○	○	○

Design Team Satisfaction	○	○	○	○	○	○	○	○	○
Construction Team Satisfaction	○	○	○	○	○	○	○	○	○
Productivity	○	○	○	○	○	○	○	○	○
Claims and Litigation	○	○	○	○	○	○	○	○	○

Impact of "shared building information model" on each of the following performance criteria.
For the purpose of this study:
Note: If you are not familiar with building information modeling, please skip this question.
shared building information model is defined as the use of one building model that has the input of all team members and that can be used by all team members.
claims and litigation is measured as economic damages resulting from claims and disputes.
construction team satisfaction is a subjective measure of how the construction team feels when working on the project and how the project fulfills its expectations.
cost performance is measured using the indicators of unit cost, percentage of cost variation relative to the budget, and net present value.
design team satisfaction is a subjective measure of how the design team feels when working on the project and how the project fulfills its expectations.
environmental impact and sustainability is measured using the criteria of the LEED certification or the ISO 14000 standard.
functionality is a subjective measure of how a project fulfills its intended function.
health and safety is measured using the indicator of number of accidents per number of man hours worked on a project
owner satisfaction is a subjective measure of how the owner feels when working on the project, how the project fulfills owner's expectations, and how likely the owner is to work with the same team in future projects.
productivity is a measure of output per unit of input, and is measured as the ratio of square footage per labor hour.
quality is a subjective measure defined as the achievement of features required to satisfy expectations of the owner, and is measured as the extent of meeting specifications.
time performance is measured using the indicators of construction time, speed of construction relative to square footage, and percentage of time variation relative to the schedule.
user satisfaction is a subjective measure of how a project satisfies the final user expectations.

	No Impact at All 1	2	3	4	5	6	7	8	Very High Impact 9
Cost Performance	○	○	○	○	○	○	○	○	○
Time Performance	○	○	○	○	○	○	○	○	○

Health and Safety	○	○	○	○	○	○	○	○	○
Environmental Impact and Sustainability	○	○	○	○	○	○	○	○	○
Quality	○	○	○	○	○	○	○	○	○
Functionality	○	○	○	○	○	○	○	○	○
User Satisfaction	○	○	○	○	○	○	○	○	○
Owner Satisfaction	○	○	○	○	○	○	○	○	○
Design Team Satisfaction	○	○	○	○	○	○	○	○	○
Construction Team Satisfaction	○	○	○	○	○	○	○	○	○
Productivity	○	○	○	○	○	○	○	○	○
Claims and Litigation	○	○	○	○	○	○	○	○	○

Impact of "intensive involvement of a knowledgeable owner" on each of the following performance criteria.
For the purpose of this study:
intensive involvement of a knowledgeable owner is defined as the active role the owner should have during the design and construction, because when the owner is involved, regular feedback exists between the owner and the rest of the team.
claims and litigation is measured as economic damages resulting from claims and disputes.
construction team satisfaction is a subjective measure of how the construction team feels when working on the project and how the project fulfills its expectations.
cost performance is measured using the indicators of unit cost, percentage of cost variation relative to the budget, and net present value.
design team satisfaction is a subjective measure of how the design team feels when working on the project and how the project fulfills its expectations.
environmental impact and sustainability is measured using the criteria of the LEED certification or the ISO 14000 standard.
functionality is a subjective measure of how a project fulfills its intended function.
health and safety is measured using the indicator of number of accidents per number of man hours worked on a project
owner satisfaction is a subjective measure of how the owner feels when working on the project, how the project fulfills owner's expectations, and how likely the owner is to work with the same team in future projects.
productivity is a measure of output per unit of input, and is measured as the ratio of square footage per labor hour.
quality is a subjective measure defined as the achievement of features required to satisfy expectations of the owner, and is measured as the extent of meeting specifications.
time performance is measured using the indicators of construction time, speed of construction relative to square footage, and percentage of time variation relative to the schedule.

user satisfaction is a subjective measure of how a project satisfies the final user expectations.

	No Impact at All 1	2	3	4	5	6	7	8	9 Very High Impact
Cost Performance	○	○	○	○	○	○	○	○	○
Time Performance	○	○	○	○	○	○	○	○	○
Health and Safety	○	○	○	○	○	○	○	○	○
Environmental Impact and Sustainability	○	○	○	○	○	○	○	○	○
Quality	○	○	○	○	○	○	○	○	○
Functionality	○	○	○	○	○	○	○	○	○
User Satisfaction	○	○	○	○	○	○	○	○	○
Owner Satisfaction	○	○	○	○	○	○	○	○	○
Design Team Satisfaction	○	○	○	○	○	○	○	○	○
Construction Team Satisfaction	○	○	○	○	○	○	○	○	○
Productivity	○	○	○	○	○	○	○	○	○
Claims and Litigation	○	○	○	○	○	○	○	○	○

Impact of "commitment of the owner" on each of the following performance criteria.
For the purpose of this study:
commitment of the owner is defined as the understanding and belief of the owner on the integrated project process and of its benefits; thereby demanding the change of the industry practitioners.
cost performance is measured using the indicators of unit cost, percentage of cost variation relative to the budget, and net present value.
time performance is measured using the indicators of construction time, speed of construction relative to square footage, and percentage of time variation relative to the schedule.
health and safety is measured using the indicator of number of accidents per number of man hours worked on a project.
environmental impact and sustainability is measured using the criteria of the LEED certification or the ISO 14000 standard.
quality is a subjective measure defined as the achievement of features required to satisfy expectations of the owner, and is measured as the extent of meeting specifications.
functionality is a subjective measure of how a project fulfills its intended function.
user satisfaction is a subjective measure of how a project satisfies the final user expectations.

owner satisfaction is a subjective measure of how the owner feels when working on the project, how the project fulfills its expectations, and how likely is to work with the same team in future projects.
design team satisfaction is a subjective measure of how the design team feels when working on the project and how the project fulfills its expectations.
construction team satisfaction is a subjective measure of how the construction team feels when working on the project and how the project fulfills its expectations.
productivity is a measure of output per unit of input, and is measured as the ratio of square footage per labor hour.
claims and litigation is measured as economic damages resulting from claims and disputes.

	No Impact at All							Very High Impact	
	1	2	3	4	5	6	7	8	9
Cost Performance	○	○	○	○	○	○	○	○	○
Time Performance	○	○	○	○	○	○	○	○	○
Health and Safety	○	○	○	○	○	○	○	○	○
Environmental Impact and Sustainability	○	○	○	○	○	○	○	○	○
Quality	○	○	○	○	○	○	○	○	○
Functionality	○	○	○	○	○	○	○	○	○
User Satisfaction	○	○	○	○	○	○	○	○	○
Owner Satisfaction	○	○	○	○	○	○	○	○	○
Design Team Satisfaction	○	○	○	○	○	○	○	○	○
Construction Team Satisfaction	○	○	○	○	○	○	○	○	○
Productivity	○	○	○	○	○	○	○	○	○
Claims and Litigation	○	○	○	○	○	○	○	○	○

Impact of "one team one location" on each of the following performance criteria.
For the purpose of this study:
one team one location is defined as setting a certain place where team members can move to work in a collaborative environment where communication is facilitated and skills and knowledge are combined in a group.
claims and litigation is measured as economic damages resulting from claims and disputes.
construction team satisfaction is a subjective measure of how the construction team feels when working on the project and how the project fulfills its expectations.
cost performance is measured using the indicators of unit cost, percentage of cost variation relative to the budget, and net present value.

design team satisfaction is a subjective measure of how the design team feels when working on the project and how the project fulfills its expectations.
environmental impact and sustainability is measured using the criteria of the LEED certification or the ISO 14000 standard.
functionality is a subjective measure of how a project fulfills its intended function.
health and safety is measured using the indicator of number of accidents per number of man hours worked on a project
owner satisfaction is a subjective measure of how the owner feels when working on the project, how the project fulfills owner's expectations, and how likely the owner is to work with the same team in future projects.
productivity is a measure of output per unit of input, and is measured as the ratio of square footage per labor hour.
quality is a subjective measure defined as the achievement of features required to satisfy expectations of the owner, and is measured as the extent of meeting specifications.
time performance is measured using the indicators of construction time, speed of construction relative to square footage, and percentage of time variation relative to the schedule.
user satisfaction is a subjective measure of how a project satisfies the final user expectations.

	No Impact at All							Very High Impact
	1	2	3	4	5	6	7	8	9
Cost Performance	○	○	○	○	○	○	○	○	○
Time Performance	○	○	○	○	○	○	○	○	○
Health and Safety	○	○	○	○	○	○	○	○	○
Environmental Impact and Sustainability	○	○	○	○	○	○	○	○	○
Quality	○	○	○	○	○	○	○	○	○
Functionality	○	○	○	○	○	○	○	○	○
User Satisfaction	○	○	○	○	○	○	○	○	○
Owner Satisfaction	○	○	○	○	○	○	○	○	○
Design Team Satisfaction	○	○	○	○	○	○	○	○	○
Construction Team Satisfaction	○	○	○	○	○	○	○	○	○
Productivity	○	○	○	○	○	○	○	○	○
Claims and Litigation	○	○	○	○	○	○	○	○	○

Impact of "open and continuous communication" on each of the following performance criteria.
For the purpose of this study:

open and continuous communication is defined as maintaining open and direct lines of communication between all project participants at all times, with no restrictions because of roles within the team.
claims and litigation is measured as economic damages resulting from claims and disputes.
construction team satisfaction is a subjective measure of how the construction team feels when working on the project and how the project fulfills its expectations.
cost performance is measured using the indicators of unit cost, percentage of cost variation relative to the budget, and net present value.
design team satisfaction is a subjective measure of how the design team feels when working on the project and how the project fulfills its expectations.
environmental impact and sustainability is measured using the criteria of the LEED certification or the ISO 14000 standard.
functionality is a subjective measure of how a project fulfills its intended function.
health and safety is measured using the indicator of number of accidents per number of man hours worked on a project
owner satisfaction is a subjective measure of how the owner feels when working on the project, how the project fulfills owner's expectations, and how likely the owner is to work with the same team in future projects.
productivity is a measure of output per unit of input, and is measured as the ratio of square footage per labor hour.
quality is a subjective measure defined as the achievement of features required to satisfy expectations of the owner, and is measured as the extent of meeting specifications.
time performance is measured using the indicators of construction time, speed of construction relative to square footage, and percentage of time variation relative to the schedule.
user satisfaction is a subjective measure of how a project satisfies the final user expectations.

	No Impact at All								Very High Impact
	1	2	3	4	5	6	7	8	9
Cost Performance	○	○	○	○	○	○	○	○	○
Time Performance	○	○	○	○	○	○	○	○	○
Health and Safety	○	○	○	○	○	○	○	○	○
Environmental Impact and Sustainability	○	○	○	○	○	○	○	○	○
Quality	○	○	○	○	○	○	○	○	○
Functionality	○	○	○	○	○	○	○	○	○
User Satisfaction	○	○	○	○	○	○	○	○	○
Owner Satisfaction	○	○	○	○	○	○	○	○	○
Design Team Satisfaction	○	○	○	○	○	○	○	○	○

Construction Team Satisfaction	○	○	○	○	○	○	○	○	○
Productivity	○	○	○	○	○	○	○	○	○
Claims and Litigation	○	○	○	○	○	○	○	○	○

Impact of "project type experience" on each of the following performance criteria.
For the purpose of this study:
project type experience is defined as the experience of the team and each individual with the type of project that is being developed.
claims and litigation is measured as economic damages resulting from claims and disputes.
construction team satisfaction is a subjective measure of how the construction team feels when working on the project and how the project fulfills its expectations.
cost performance is measured using the indicators of unit cost, percentage of cost variation relative to the budget, and net present value.
design team satisfaction is a subjective measure of how the design team feels when working on the project and how the project fulfills its expectations.
environmental impact and sustainability is measured using the criteria of the LEED certification or the ISO 14000 standard.
functionality is a subjective measure of how a project fulfills its intended function.
health and safety is measured using the indicator of number of accidents per number of man hours worked on a project
owner satisfaction is a subjective measure of how the owner feels when working on the project, how the project fulfills owner's expectations, and how likely the owner is to work with the same team in future projects.
productivity is a measure of output per unit of input, and is measured as the ratio of square footage per labor hour.
quality is a subjective measure defined as the achievement of features required to satisfy expectations of the owner, and is measured as the extent of meeting specifications.
time performance is measured using the indicators of construction time, speed of construction relative to square footage, and percentage of time variation relative to the schedule.
user satisfaction is a subjective measure of how a project satisfies the final user expectations.

	No Impact at All								Very High Impact
	1	2	3	4	5	6	7	8	9
Cost Performance	○	○	○	○	○	○	○	○	○
Time Performance	○	○	○	○	○	○	○	○	○
Health and Safety	○	○	○	○	○	○	○	○	○
Environmental Impact and Sustainability	○	○	○	○	○	○	○	○	○
Quality	○	○	○	○	○	○	○	○	○

Functionality	○	○	○	○	○	○	○	○	○
User Satisfaction	○	○	○	○	○	○	○	○	○
Owner Satisfaction	○	○	○	○	○	○	○	○	○
Design Team Satisfaction	○	○	○	○	○	○	○	○	○
Construction Team Satisfaction	○	○	○	○	○	○	○	○	○
Productivity	○	○	○	○	○	○	○	○	○
Claims and Litigation	○	○	○	○	○	○	○	○	○

Impact of "organization and project manager leadership" on each of the following performance criteria.
For the purpose of this study:
organization and project manager leadership is defined as the belief, attitude and commitment of the project manager and other leaders of the project towards integration in order to encourage integration and to motivate the team.
claims and litigation is measured as economic damages resulting from claims and disputes.
construction team satisfaction is a subjective measure of how the construction team feels when working on the project and how the project fulfills its expectations.
cost performance is measured using the indicators of unit cost, percentage of cost variation relative to the budget, and net present value.
design team satisfaction is a subjective measure of how the design team feels when working on the project and how the project fulfills its expectations.
environmental impact and sustainability is measured using the criteria of the LEED certification or the ISO 14000 standard.
functionality is a subjective measure of how a project fulfills its intended function.
health and safety is measured using the indicator of number of accidents per number of man hours worked on a project
owner satisfaction is a subjective measure of how the owner feels when working on the project, how the project fulfills owner's expectations, and how likely the owner is to work with the same team in future projects.
productivity is a measure of output per unit of input, and is measured as the ratio of square footage per labor hour.
quality is a subjective measure defined as the achievement of features required to satisfy expectations of the owner, and is measured as the extent of meeting specifications.
time performance is measured using the indicators of construction time, speed of construction relative to square footage, and percentage of time variation relative to the schedule.
user satisfaction is a subjective measure of how a project satisfies the final user expectations.

	No Impact at All					Very High Impact			
	1	2	3	4	5	6	7	8	9
Cost Performance	○	○	○	○	○	○	○	○	○
Time Performance	○	○	○	○	○	○	○	○	○
Health and Safety	○	○	○	○	○	○	○	○	○
Environmental Impact and Sustainability	○	○	○	○	○	○	○	○	○
Quality	○	○	○	○	○	○	○	○	○
Functionality	○	○	○	○	○	○	○	○	○
User Satisfaction	○	○	○	○	○	○	○	○	○
Owner Satisfaction	○	○	○	○	○	○	○	○	○
Design Team Satisfaction	○	○	○	○	○	○	○	○	○
Construction Team Satisfaction	○	○	○	○	○	○	○	○	○
Productivity	○	○	○	○	○	○	○	○	○
Claims and Litigation	○	○	○	○	○	○	○	○	○

Impact of "information share and exchange" on each of the following performance criteria.
For the purpose of this study:
information share and exchange is defined as the open, quick, effective and free flow of information from one organization to the other and among team members.
claims and litigation is measured as economic damages resulting from claims and disputes.
construction team satisfaction is a subjective measure of how the construction team feels when working on the project and how the project fulfills its expectations.
cost performance is measured using the indicators of unit cost, percentage of cost variation relative to the budget, and net present value.
design team satisfaction is a subjective measure of how the design team feels when working on the project and how the project fulfills its expectations.
environmental impact and sustainability is measured using the criteria of the LEED certification or the ISO 14000 standard.
functionality is a subjective measure of how a project fulfills its intended function.
health and safety is measured using the indicator of number of accidents per number of man hours worked on a project
owner satisfaction is a subjective measure of how the owner feels when working on the project, how the project fulfills owner's expectations, and how likely the owner is to work with the same team in future projects.
productivity is a measure of output per unit of input, and is measured as the ratio of square footage per labor hour.

quality is a subjective measure defined as the achievement of features required to satisfy expectations of the owner, and is measured as the extent of meeting specifications.
time performance is measured using the indicators of construction time, speed of construction relative to square footage, and percentage of time variation relative to the schedule.
user satisfaction is a subjective measure of how a project satisfies the final user expectations.

	No Impact at All								Very High Impact
	1	2	3	4	5	6	7	8	9
Cost Performance	○	○	○	○	○	○	○	○	○
Time Performance	○	○	○	○	○	○	○	○	○
Health and Safety	○	○	○	○	○	○	○	○	○
Environmental Impact and Sustainability	○	○	○	○	○	○	○	○	○
Quality	○	○	○	○	○	○	○	○	○
Functionality	○	○	○	○	○	○	○	○	○
User Satisfaction	○	○	○	○	○	○	○	○	○
Owner Satisfaction	○	○	○	○	○	○	○	○	○
Design Team Satisfaction	○	○	○	○	○	○	○	○	○
Construction Team Satisfaction	○	○	○	○	○	○	○	○	○
Productivity	○	○	○	○	○	○	○	○	○
Claims and Litigation	○	○	○	○	○	○	○	○	○

Impact of "continuous improvement" on each of the following performance criteria.
For the purpose of this study:
continuous improvement is defined as the ability and capability to improve as the project progresses and after the project is over in order to generate knowledge and to transfer knowledge, therefore decisions should be evaluated at different stages of the project in an iterative process that helps those decisions reflect broad team knowledge and the understanding of all interactions, feedback should exist, lessons learned should be evaluated during the project and after it, and a post project evaluation should exists.
claims and litigation is measured as economic damages resulting from claims and disputes.
construction team satisfaction is a subjective measure of how the construction team feels when working on the project and how the project fulfills its expectations.
cost performance is measured using the indicators of unit cost, percentage of cost variation relative to the budget, and net present value.
design team satisfaction is a subjective measure of how the design team feels when working on the project and how the project fulfills its expectations.

environmental impact and sustainability is measured using the criteria of the LEED certification or the ISO 14000 standard.
functionality is a subjective measure of how a project fulfills its intended function.
health and safety is measured using the indicator of number of accidents per number of man hours worked on a project
owner satisfaction is a subjective measure of how the owner feels when working on the project, how the project fulfills owner's expectations, and how likely the owner is to work with the same team in future projects.
productivity is a measure of output per unit of input, and is measured as the ratio of square footage per labor hour.
quality is a subjective measure defined as the achievement of features required to satisfy expectations of the owner, and is measured as the extent of meeting specifications.
time performance is measured using the indicators of construction time, speed of construction relative to square footage, and percentage of time variation relative to the schedule.
user satisfaction is a subjective measure of how a project satisfies the final user expectations.

	No Impact at All 1	2	3	4	5	6	7	8	Very High Impact 9
Cost Performance	○	○	○	○	○	○	○	○	○
Time Performance	○	○	○	○	○	○	○	○	○
Health and Safety	○	○	○	○	○	○	○	○	○
Environmental Impact and Sustainability	○	○	○	○	○	○	○	○	○
Quality	○	○	○	○	○	○	○	○	○
Functionality	○	○	○	○	○	○	○	○	○
User Satisfaction	○	○	○	○	○	○	○	○	○
Owner Satisfaction	○	○	○	○	○	○	○	○	○
Design Team Satisfaction	○	○	○	○	○	○	○	○	○
Construction Team Satisfaction	○	○	○	○	○	○	○	○	○
Productivity	○	○	○	○	○	○	○	○	○
Claims and Litigation	○	○	○	○	○	○	○	○	○

Impact of "knowledge sharing" on each of the following performance criteria.
For the purpose of this study:
knowledge sharing is defined as the exchange of talent and knowledge between team members by exchanging ideas and attacking problems simultaneously from different disciplines.

claims and litigation is measured as economic damages resulting from claims and disputes.
construction team satisfaction is a subjective measure of how the construction team feels when working on the project and how the project fulfills its expectations.
cost performance is measured using the indicators of unit cost, percentage of cost variation relative to the budget, and net present value.
design team satisfaction is a subjective measure of how the design team feels when working on the project and how the project fulfills its expectations.
environmental impact and sustainability is measured using the criteria of the LEED certification or the ISO 14000 standard.
functionality is a subjective measure of how a project fulfills its intended function.
health and safety is measured using the indicator of number of accidents per number of man hours worked on a project
owner satisfaction is a subjective measure of how the owner feels when working on the project, how the project fulfills owner's expectations, and how likely the owner is to work with the same team in future projects.
productivity is a measure of output per unit of input, and is measured as the ratio of square footage per labor hour.
quality is a subjective measure defined as the achievement of features required to satisfy expectations of the owner, and is measured as the extent of meeting specifications.
time performance is measured using the indicators of construction time, speed of construction relative to square footage, and percentage of time variation relative to the schedule.
user satisfaction is a subjective measure of how a project satisfies the final user expectations.

	No Impact at All 1	2	3	4	5	6	7	8	9 Very High Impact
Cost Performance	○	○	○	○	○	○	○	○	○
Time Performance	○	○	○	○	○	○	○	○	○
Health and Safety	○	○	○	○	○	○	○	○	○
Environmental Impact and Sustainability	○	○	○	○	○	○	○	○	○
Quality	○	○	○	○	○	○	○	○	○
Functionality	○	○	○	○	○	○	○	○	○
User Satisfaction	○	○	○	○	○	○	○	○	○
Owner Satisfaction	○	○	○	○	○	○	○	○	○
Design Team Satisfaction	○	○	○	○	○	○	○	○	○
Construction Team Satisfaction	○	○	○	○	○	○	○	○	○
Productivity	○	○	○	○	○	○	○	○	○

Claims and Litigation	○	○	○	○	○	○	○	○	○

Impact of "eliminate multilayer subcontracting structure" on each of the following performance criteria.
For the purpose of this study:
eliminate multilayer subcontracting structure is defined as a structure where the general contractor or the project manager hires directly the subcontractor that is going to perform the work increasing the accountability of parties involved.
claims and litigation is measured as economic damages resulting from claims and disputes.
construction team satisfaction is a subjective measure of how the construction team feels when working on the project and how the project fulfills its expectations.
cost performance is measured using the indicators of unit cost, percentage of cost variation relative to the budget, and net present value.
design team satisfaction is a subjective measure of how the design team feels when working on the project and how the project fulfills its expectations.
environmental impact and sustainability is measured using the criteria of the LEED certification or the ISO 14000 standard.
functionality is a subjective measure of how a project fulfills its intended function.
health and safety is measured using the indicator of number of accidents per number of man hours worked on a project
owner satisfaction is a subjective measure of how the owner feels when working on the project, how the project fulfills owner's expectations, and how likely the owner is to work with the same team in future projects.
productivity is a measure of output per unit of input, and is measured as the ratio of square footage per labor hour.
quality is a subjective measure defined as the achievement of features required to satisfy expectations of the owner, and is measured as the extent of meeting specifications.
time performance is measured using the indicators of construction time, speed of construction relative to square footage, and percentage of time variation relative to the schedule.
user satisfaction is a subjective measure of how a project satisfies the final user expectations.

	No Impact at All 1	2	3	4	5	6	7	8	Very High Impact 9
Cost Performance	○	○	○	○	○	○	○	○	○
Time Performance	○	○	○	○	○	○	○	○	○
Health and Safety	○	○	○	○	○	○	○	○	○
Environmental Impact and Sustainability	○	○	○	○	○	○	○	○	○
Quality	○	○	○	○	○	○	○	○	○
Functionality	○	○	○	○	○	○	○	○	○
User Satisfaction	○	○	○	○	○	○	○	○	○

Owner Satisfaction	○	○	○	○	○	○	○	○	○
Design Team Satisfaction	○	○	○	○	○	○	○	○	○
Construction Team Satisfaction	○	○	○	○	○	○	○	○	○
Productivity	○	○	○	○	○	○	○	○	○
Claims and Litigation	○	○	○	○	○	○	○	○	○

Impact of "common goals and objectives" on each of the following performance criteria.
For the purpose of this study:
common goals and objectives is defined as an alignment between project goals, stakeholders' goals and individual's goals.
claims and litigation is measured as economic damages resulting from claims and disputes.
construction team satisfaction is a subjective measure of how the construction team feels when working on the project and how the project fulfills its expectations.
cost performance is measured using the indicators of unit cost, percentage of cost variation relative to the budget, and net present value.
design team satisfaction is a subjective measure of how the design team feels when working on the project and how the project fulfills its expectations.
environmental impact and sustainability is measured using the criteria of the LEED certification or the ISO 14000 standard.
functionality is a subjective measure of how a project fulfills its intended function.
health and safety is measured using the indicator of number of accidents per number of man hours worked on a project
owner satisfaction is a subjective measure of how the owner feels when working on the project, how the project fulfills owner's expectations, and how likely the owner is to work with the same team in future projects.
productivity is a measure of output per unit of input, and is measured as the ratio of square footage per labor hour.
quality is a subjective measure defined as the achievement of features required to satisfy expectations of the owner, and is measured as the extent of meeting specifications.
time performance is measured using the indicators of construction time, speed of construction relative to square footage, and percentage of time variation relative to the schedule.
user satisfaction is a subjective measure of how a project satisfies the final user expectations.

	No Impact at All 1	2	3	4	5	6	7	8	Very High Impact 9
Cost Performance	○	○	○	○	○	○	○	○	○
Time Performance	○	○	○	○	○	○	○	○	○
Health and Safety	○	○	○	○	○	○	○	○	○

Environmental Impact and Sustainability	○	○	○	○	○	○	○	○	○
Quality	○	○	○	○	○	○	○	○	○
Functionality	○	○	○	○	○	○	○	○	○
User Satisfaction	○	○	○	○	○	○	○	○	○
Owner Satisfaction	○	○	○	○	○	○	○	○	○
Design Team Satisfaction	○	○	○	○	○	○	○	○	○
Construction Team Satisfaction	○	○	○	○	○	○	○	○	○
Productivity	○	○	○	○	○	○	○	○	○
Claims and Litigation	○	○	○	○	○	○	○	○	○

of "clear responsibilities and clear accountability structure" on each of the following performance criteria.
For the purpose of this study:
clear responsibilities and clear accountability structure is defined as structure defined up front that explicitly states responsibilities within the project and how those responsibilities will be assessed as the project progresses.
claims and litigation is measured as economic damages resulting from claims and disputes.
construction team satisfaction is a subjective measure of how the construction team feels when working on the project and how the project fulfills its expectations.
cost performance is measured using the indicators of unit cost, percentage of cost variation relative to the budget, and net present value.
design team satisfaction is a subjective measure of how the design team feels when working on the project and how the project fulfills its expectations.
environmental impact and sustainability is measured using the criteria of the LEED certification or the ISO 14000 standard.
functionality is a subjective measure of how a project fulfills its intended function.
health and safety is measured using the indicator of number of accidents per number of man hours worked on a project
owner satisfaction is a subjective measure of how the owner feels when working on the project, how the project fulfills owner's expectations, and how likely the owner is to work with the same team in future projects.
productivity is a measure of output per unit of input, and is measured as the ratio of square footage per labor hour.
quality is a subjective measure defined as the achievement of features required to satisfy expectations of the owner, and is measured as the extent of meeting specifications.
time performance is measured using the indicators of construction time, speed of construction relative to square footage, and percentage of time variation relative to the schedule.
user satisfaction is a subjective measure of how a project satisfies the final user expectations.

	No Impact at All 1	2	3	4	5	6	7	8	9 Very High Impact
Cost Performance	○	○	○	○	○	○	○	○	○
Time Performance	○	○	○	○	○	○	○	○	○
Health and Safety	○	○	○	○	○	○	○	○	○
Environmental Impact and Sustainability	○	○	○	○	○	○	○	○	○
Quality	○	○	○	○	○	○	○	○	○
Functionality	○	○	○	○	○	○	○	○	○
User Satisfaction	○	○	○	○	○	○	○	○	○
Owner Satisfaction	○	○	○	○	○	○	○	○	○
Design Team Satisfaction	○	○	○	○	○	○	○	○	○
Construction Team Satisfaction	○	○	○	○	○	○	○	○	○
Productivity	○	○	○	○	○	○	○	○	○
Claims and Litigation	○	○	○	○	○	○	○	○	○

Impact of "contracting structure that fosters collaboration" on each of the following performance criteria.
For the purpose of this study:
contracting structure that fosters collaboration is defined as an agreement that sets how the different parties are going to interact in the project and who is responsible to whom, in a way that fosters collaboration and communication, integrating the efforts of the entire team.
claims and litigation is measured as economic damages resulting from claims and disputes.
construction team satisfaction is a subjective measure of how the construction team feels when working on the project and how the project fulfills its expectations.
cost performance is measured using the indicators of unit cost, percentage of cost variation relative to the budget, and net present value.
design team satisfaction is a subjective measure of how the design team feels when working on the project and how the project fulfills its expectations.
environmental impact and sustainability is measured using the criteria of the LEED certification or the ISO 14000 standard.
functionality is a subjective measure of how a project fulfills its intended function.
health and safety is measured using the indicator of number of accidents per number of man hours worked on a project
owner satisfaction is a subjective measure of how the owner feels when working on the project, how the project fulfills owner's expectations, and how likely the owner is to work with the same team in future projects.

productivity is a measure of output per unit of input, and is measured as the ratio of square footage per labor hour.
quality is a subjective measure defined as the achievement of features required to satisfy expectations of the owner, and is measured as the extent of meeting specifications.
time performance is measured using the indicators of construction time, speed of construction relative to square footage, and percentage of time variation relative to the schedule.
user satisfaction is a subjective measure of how a project satisfies the final user expectations.

	No Impact at All								Very High Impact
	1	2	3	4	5	6	7	8	9
Cost Performance	○	○	○	○	○	○	○	○	○
Time Performance	○	○	○	○	○	○	○	○	○
Health and Safety	○	○	○	○	○	○	○	○	○
Environmental Impact and Sustainability	○	○	○	○	○	○	○	○	○
Quality	○	○	○	○	○	○	○	○	○
Functionality	○	○	○	○	○	○	○	○	○
User Satisfaction	○	○	○	○	○	○	○	○	○
Owner Satisfaction	○	○	○	○	○	○	○	○	○
Design Team Satisfaction	○	○	○	○	○	○	○	○	○
Construction Team Satisfaction	○	○	○	○	○	○	○	○	○
Productivity	○	○	○	○	○	○	○	○	○
Claims and Litigation	○	○	○	○	○	○	○	○	○

Impact of "use of facilitator" on each of the following performance criteria.
For the purpose of this study:
use of facilitator is defined as having a person who can help develop communication skills, foster respect and trust, guide the project team in the integration process, align individual goals and project goals, eliminate the fear of conflict, get commitment from the different stakeholders, make each party accountable for their responsibilities, and have leadership skills.
claims and litigation is measured as economic damages resulting from claims and disputes.
construction team satisfaction is a subjective measure of how the construction team feels when working on the project and how the project fulfills its expectations.
cost performance is measured using the indicators of unit cost, percentage of cost variation relative to the budget, and net present value.
design team satisfaction is a subjective measure of how the design team feels when working on the project and how the project fulfills its expectations.

environmental impact and sustainability is measured using the criteria of the LEED certification or the ISO 14000 standard.
functionality is a subjective measure of how a project fulfills its intended function.
health and safety is measured using the indicator of number of accidents per number of man hours worked on a project
owner satisfaction is a subjective measure of how the owner feels when working on the project, how the project fulfills owner's expectations, and how likely the owner is to work with the same team in future projects.
productivity is a measure of output per unit of input, and is measured as the ratio of square footage per labor hour.
quality is a subjective measure defined as the achievement of features required to satisfy expectations of the owner, and is measured as the extent of meeting specifications.
time performance is measured using the indicators of construction time, speed of construction relative to square footage, and percentage of time variation relative to the schedule.
user satisfaction is a subjective measure of how a project satisfies the final user expectations.

	No Impact at All 1	2	3	4	5	6	7	8	9 Very High Impact
Cost Performance	○	○	○	○	○	○	○	○	○
Time Performance	○	○	○	○	○	○	○	○	○
Health and Safety	○	○	○	○	○	○	○	○	○
Environmental Impact and Sustainability	○	○	○	○	○	○	○	○	○
Quality	○	○	○	○	○	○	○	○	○
Functionality	○	○	○	○	○	○	○	○	○
User Satisfaction	○	○	○	○	○	○	○	○	○
Owner Satisfaction	○	○	○	○	○	○	○	○	○
Design Team Satisfaction	○	○	○	○	○	○	○	○	○
Construction Team Satisfaction	○	○	○	○	○	○	○	○	○
Productivity	○	○	○	○	○	○	○	○	○
Claims and Litigation	○	○	○	○	○	○	○	○	○

Impact of "project delivery method selection" on each of the following performance criteria.
For the purpose of this study:
project delivery method selection is defined as the selection of the method that determines relationship and interactions between project members.

claims and litigation is measured as economic damages resulting from claims and disputes.
construction team satisfaction is a subjective measure of how the construction team feels when working on the project and how the project fulfills its expectations.
cost performance is measured using the indicators of unit cost, percentage of cost variation relative to the budget, and net present value.
design team satisfaction is a subjective measure of how the design team feels when working on the project and how the project fulfills its expectations.
environmental impact and sustainability is measured using the criteria of the LEED certification or the ISO 14000 standard.
functionality is a subjective measure of how a project fulfills its intended function.
health and safety is measured using the indicator of number of accidents per number of man hours worked on a project
owner satisfaction is a subjective measure of how the owner feels when working on the project, how the project fulfills owner's expectations, and how likely the owner is to work with the same team in future projects.
productivity is a measure of output per unit of input, and is measured as the ratio of square footage per labor hour.
quality is a subjective measure defined as the achievement of features required to satisfy expectations of the owner, and is measured as the extent of meeting specifications.
time performance is measured using the indicators of construction time, speed of construction relative to square footage, and percentage of time variation relative to the schedule.
user satisfaction is a subjective measure of how a project satisfies the final user expectations.

	No Impact at All 1	2	3	4	5	6	7	8	Very High Impact 9
Cost Performance	○	○	○	○	○	○	○	○	○
Time Performance	○	○	○	○	○	○	○	○	○
Health and Safety	○	○	○	○	○	○	○	○	○
Environmental Impact and Sustainability	○	○	○	○	○	○	○	○	○
Quality	○	○	○	○	○	○	○	○	○
Functionality	○	○	○	○	○	○	○	○	○
User Satisfaction	○	○	○	○	○	○	○	○	○
Owner Satisfaction	○	○	○	○	○	○	○	○	○
Design Team Satisfaction	○	○	○	○	○	○	○	○	○
Construction Team Satisfaction	○	○	○	○	○	○	○	○	○
Productivity	○	○	○	○	○	○	○	○	○

Claims and Litigation	○	○	○	○	○	○	○	○	○

Impact of "adequate resources" on each of the following performance criteria.
For the purpose of this study:
adequate resources is defined as the availability of resources in terms of knowledge, technology, information, specific skills, capital and time when needed.
claims and litigation is measured as economic damages resulting from claims and disputes.
construction team satisfaction is a subjective measure of how the construction team feels when working on the project and how the project fulfills its expectations.
cost performance is measured using the indicators of unit cost, percentage of cost variation relative to the budget, and net present value.
design team satisfaction is a subjective measure of how the design team feels when working on the project and how the project fulfills its expectations.
environmental impact and sustainability is measured using the criteria of the LEED certification or the ISO 14000 standard.
functionality is a subjective measure of how a project fulfills its intended function.
health and safety is measured using the indicator of number of accidents per number of man hours worked on a project
owner satisfaction is a subjective measure of how the owner feels when working on the project, how the project fulfills owner's expectations, and how likely the owner is to work with the same team in future projects.
productivity is a measure of output per unit of input, and is measured as the ratio of square footage per labor hour.
quality is a subjective measure defined as the achievement of features required to satisfy expectations of the owner, and is measured as the extent of meeting specifications.
time performance is measured using the indicators of construction time, speed of construction relative to square footage, and percentage of time variation relative to the schedule.
user satisfaction is a subjective measure of how a project satisfies the final user expectations.

	No Impact at All							Very High Impact	
	1	2	3	4	5	6	7	8	9
Cost Performance	○	○	○	○	○	○	○	○	○
Time Performance	○	○	○	○	○	○	○	○	○
Health and Safety	○	○	○	○	○	○	○	○	○
Environmental Impact and Sustainability	○	○	○	○	○	○	○	○	○
Quality	○	○	○	○	○	○	○	○	○
Functionality	○	○	○	○	○	○	○	○	○
User Satisfaction	○	○	○	○	○	○	○	○	○

	1	2	3	4	5	6	7	8	9
Owner Satisfaction	○	○	○	○	○	○	○	○	○
Design Team Satisfaction	○	○	○	○	○	○	○	○	○
Construction Team Satisfaction	○	○	○	○	○	○	○	○	○
Productivity	○	○	○	○	○	○	○	○	○
Claims and Litigation	○	○	○	○	○	○	○	○	○

Impact of "support from top management" on each of the following performance criteria.
For the purpose of this study:
support from top management is defined as the commitment and belief in an integrated process of top management from parent organization of team members, who formulate the strategy and the direction of business activities.
claims and litigation is measured as economic damages resulting from claims and disputes.
construction team satisfaction is a subjective measure of how the construction team feels when working on the project and how the project fulfills its expectations.
cost performance is measured using the indicators of unit cost, percentage of cost variation relative to the budget, and net present value.
design team satisfaction is a subjective measure of how the design team feels when working on the project and how the project fulfills its expectations.
environmental impact and sustainability is measured using the criteria of the LEED certification or the ISO 14000 standard.
functionality is a subjective measure of how a project fulfills its intended function.
health and safety is measured using the indicator of number of accidents per number of man hours worked on a project
owner satisfaction is a subjective measure of how the owner feels when working on the project, how the project fulfills owner's expectations, and how likely the owner is to work with the same team in future projects.
productivity is a measure of output per unit of input, and is measured as the ratio of square footage per labor hour.
quality is a subjective measure defined as the achievement of features required to satisfy expectations of the owner, and is measured as the extent of meeting specifications.
time performance is measured using the indicators of construction time, speed of construction relative to square footage, and percentage of time variation relative to the schedule.
user satisfaction is a subjective measure of how a project satisfies the final user expectations.

	No Impact at All 1	2	3	4	5	6	7	8	Very High Impact 9
Cost Performance	○	○	○	○	○	○	○	○	○
Time Performance	○	○	○	○	○	○	○	○	○
Health and Safety	○	○	○	○	○	○	○	○	○

Environmental Impact and Sustainability	○	○	○	○	○	○	○	○	○
Quality	○	○	○	○	○	○	○	○	○
Functionality	○	○	○	○	○	○	○	○	○
User Satisfaction	○	○	○	○	○	○	○	○	○
Owner Satisfaction	○	○	○	○	○	○	○	○	○
Design Team Satisfaction	○	○	○	○	○	○	○	○	○
Construction Team Satisfaction	○	○	○	○	○	○	○	○	○
Productivity	○	○	○	○	○	○	○	○	○
Claims and Litigation	○	○	○	○	○	○	○	○	○

Impact of "long term commitment" on each of the following performance criteria.
For the purpose of this study:
long term commitment is defined as the commitment of the different parties to work together in future work, thereby parties can balance the attainment of short term objectives with long-term goals; reducing the fear for opportunistic behavior, eliminating waste in the process, and improving projects by learning from experience.
claims and litigation is measured as economic damages resulting from claims and disputes.
construction team satisfaction is a subjective measure of how the construction team feels when working on the project and how the project fulfills its expectations.
cost performance is measured using the indicators of unit cost, percentage of cost variation relative to the budget, and net present value.
design team satisfaction is a subjective measure of how the design team feels when working on the project and how the project fulfills its expectations.
environmental impact and sustainability is measured using the criteria of the LEED certification or the ISO 14000 standard.
functionality is a subjective measure of how a project fulfills its intended function.
health and safety is measured using the indicator of number of accidents per number of man hours worked on a project
owner satisfaction is a subjective measure of how the owner feels when working on the project, how the project fulfills owner's expectations, and how likely the owner is to work with the same team in future projects.
productivity is a measure of output per unit of input, and is measured as the ratio of square footage per labor hour.
quality is a subjective measure defined as the achievement of features required to satisfy expectations of the owner, and is measured as the extent of meeting specifications.
time performance is measured using the indicators of construction time, speed of construction relative to square footage, and percentage of time variation relative to the schedule.
user satisfaction is a subjective measure of how a project satisfies the final user expectations.

	No Impact at All 1	2	3	4	5	6	7	8	Very High Impact 9
Cost Performance	○	○	○	○	○	○	○	○	○
Time Performance	○	○	○	○	○	○	○	○	○
Health and Safety	○	○	○	○	○	○	○	○	○
Environmental Impact and Sustainability	○	○	○	○	○	○	○	○	○
Quality	○	○	○	○	○	○	○	○	○
Functionality	○	○	○	○	○	○	○	○	○
User Satisfaction	○	○	○	○	○	○	○	○	○
Owner Satisfaction	○	○	○	○	○	○	○	○	○
Design Team Satisfaction	○	○	○	○	○	○	○	○	○
Construction Team Satisfaction	○	○	○	○	○	○	○	○	○
Productivity	○	○	○	○	○	○	○	○	○
Claims and Litigation	○	○	○	○	○	○	○	○	○

Impact of "efficient coordination" on each of the following performance criteria.
For the purpose of this study:
efficient coordination is defined as the ability of the entire team of combining all project parts in a way that they do not present conflict. It can be achieved by sharing project information and by facilitating points of contact between the different parties.
claims and litigation is measured as economic damages resulting from claims and disputes.
construction team satisfaction is a subjective measure of how the construction team feels when working on the project and how the project fulfills its expectations.
cost performance is measured using the indicators of unit cost, percentage of cost variation relative to the budget, and net present value.
design team satisfaction is a subjective measure of how the design team feels when working on the project and how the project fulfills its expectations.
environmental impact and sustainability is measured using the criteria of the LEED certification or the ISO 14000 standard.
functionality is a subjective measure of how a project fulfills its intended function.
health and safety is measured using the indicator of number of accidents per number of man hours worked on a project
owner satisfaction is a subjective measure of how the owner feels when working on the project, how the project fulfills owner's expectations, and how likely the owner is to work with the same team in future projects.
productivity is a measure of output per unit of input, and is measured as the ratio of square footage per labor hour.

quality is a subjective measure defined as the achievement of features required to satisfy expectations of the owner, and is measured as the extent of meeting specifications.
time performance is measured using the indicators of construction time, speed of construction relative to square footage, and percentage of time variation relative to the schedule.
user satisfaction is a subjective measure of how a project satisfies the final user expectations.

	No Impact at All								Very High Impact
	1	2	3	4	5	6	7	8	9
Cost Performance	○	○	○	○	○	○	○	○	○
Time Performance	○	○	○	○	○	○	○	○	○
Health and Safety	○	○	○	○	○	○	○	○	○
Environmental Impact and Sustainability	○	○	○	○	○	○	○	○	○
Quality	○	○	○	○	○	○	○	○	○
Functionality	○	○	○	○	○	○	○	○	○
User Satisfaction	○	○	○	○	○	○	○	○	○
Owner Satisfaction	○	○	○	○	○	○	○	○	○
Design Team Satisfaction	○	○	○	○	○	○	○	○	○
Construction Team Satisfaction	○	○	○	○	○	○	○	○	○
Productivity	○	○	○	○	○	○	○	○	○
Claims and Litigation	○	○	○	○	○	○	○	○	○

Impact of "understanding of other parties' needs, expectations and disciplines" on each of the following performance criteria.
For the purpose of this study:
understanding of other parties' needs, expectations and disciplines is defined as the ability of each party to understand the goals, objectives, mission, needs, technologies, finances and operations, and disciplines of other participants.
claims and litigation is measured as economic damages resulting from claims and disputes.
construction team satisfaction is a subjective measure of how the construction team feels when working on the project and how the project fulfills its expectations.
cost performance is measured using the indicators of unit cost, percentage of cost variation relative to the budget, and net present value.
design team satisfaction is a subjective measure of how the design team feels when working on the project and how the project fulfills its expectations.
environmental impact and sustainability is measured using the criteria of the LEED certification or the ISO 14000 standard.

functionality is a subjective measure of how a project fulfills its intended function.
health and safety is measured using the indicator of number of accidents per number of man hours worked on a project
owner satisfaction is a subjective measure of how the owner feels when working on the project, how the project fulfills owner's expectations, and how likely the owner is to work with the same team in future projects.
productivity is a measure of output per unit of input, and is measured as the ratio of square footage per labor hour.
quality is a subjective measure defined as the achievement of features required to satisfy expectations of the owner, and is measured as the extent of meeting specifications.
time performance is measured using the indicators of construction time, speed of construction relative to square footage, and percentage of time variation relative to the schedule.
user satisfaction is a subjective measure of how a project satisfies the final user expectations.

	No Impact at All 1	2	3	4	5	6	7	8	Very High Impact 9
Cost Performance	○	○	○	○	○	○	○	○	○
Time Performance	○	○	○	○	○	○	○	○	○
Health and Safety	○	○	○	○	○	○	○	○	○
Environmental Impact and Sustainability	○	○	○	○	○	○	○	○	○
Quality	○	○	○	○	○	○	○	○	○
Functionality	○	○	○	○	○	○	○	○	○
User Satisfaction	○	○	○	○	○	○	○	○	○
Owner Satisfaction	○	○	○	○	○	○	○	○	○
Design Team Satisfaction	○	○	○	○	○	○	○	○	○
Construction Team Satisfaction	○	○	○	○	○	○	○	○	○
Productivity	○	○	○	○	○	○	○	○	○
Claims and Litigation	○	○	○	○	○	○	○	○	○

Impact of "subcontractor and supplier involvement" on each of the following performance criteria.
For the purpose of this study:
subcontractor and supplier involvement is defined as the involvement of subcontractors and suppliers as part of the project team key players early in the process as they are the ones who are actually performing the work on field.
claims and litigation is measured as economic damages resulting from claims and disputes.

construction team satisfaction is a subjective measure of how the construction team feels when working on the project and how the project fulfills its expectations.
cost performance is measured using the indicators of unit cost, percentage of cost variation relative to the budget, and net present value.
design team satisfaction is a subjective measure of how the design team feels when working on the project and how the project fulfills its expectations.
environmental impact and sustainability is measured using the criteria of the LEED certification or the ISO 14000 standard.
functionality is a subjective measure of how a project fulfills its intended function.
health and safety is measured using the indicator of number of accidents per number of man hours worked on a project
owner satisfaction is a subjective measure of how the owner feels when working on the project, how the project fulfills owner's expectations, and how likely the owner is to work with the same team in future projects.
productivity is a measure of output per unit of input, and is measured as the ratio of square footage per labor hour.
quality is a subjective measure defined as the achievement of features required to satisfy expectations of the owner, and is measured as the extent of meeting specifications.
time performance is measured using the indicators of construction time, speed of construction relative to square footage, and percentage of time variation relative to the schedule.
user satisfaction is a subjective measure of how a project satisfies the final user expectations.

	No Impact at All 1	2	3	4	5	6	7	8	Very High Impact 9
Cost Performance	○	○	○	○	○	○	○	○	○
Time Performance	○	○	○	○	○	○	○	○	○
Health and Safety	○	○	○	○	○	○	○	○	○
Environmental Impact and Sustainability	○	○	○	○	○	○	○	○	○
Quality	○	○	○	○	○	○	○	○	○
Functionality	○	○	○	○	○	○	○	○	○
User Satisfaction	○	○	○	○	○	○	○	○	○
Owner Satisfaction	○	○	○	○	○	○	○	○	○
Design Team Satisfaction	○	○	○	○	○	○	○	○	○
Construction Team Satisfaction	○	○	○	○	○	○	○	○	○
Productivity	○	○	○	○	○	○	○	○	○
Claims and Litigation	○	○	○	○	○	○	○	○	○

Impact of "facility manager involvement" on each of the following performance criteria.
For the purpose of this study:
facility manager involvement is defined as the involvement of the facility manager as part of the project team key players early in the process as they are ones who know the requirements of maintenance and operations as well as the expectations of final users.
claims and litigation is measured as economic damages resulting from claims and disputes.
construction team satisfaction is a subjective measure of how the construction team feels when working on the project and how the project fulfills its expectations.
cost performance is measured using the indicators of unit cost, percentage of cost variation relative to the budget, and net present value.
design team satisfaction is a subjective measure of how the design team feels when working on the project and how the project fulfills its expectations.
environmental impact and sustainability is measured using the criteria of the LEED certification or the ISO 14000 standard.
functionality is a subjective measure of how a project fulfills its intended function.
health and safety is measured using the indicator of number of accidents per number of man hours worked on a project
owner satisfaction is a subjective measure of how the owner feels when working on the project, how the project fulfills owner's expectations, and how likely the owner is to work with the same team in future projects.
productivity is a measure of output per unit of input, and is measured as the ratio of square footage per labor hour.
quality is a subjective measure defined as the achievement of features required to satisfy expectations of the owner, and is measured as the extent of meeting specifications.
time performance is measured using the indicators of construction time, speed of construction relative to square footage, and percentage of time variation relative to the schedule.
user satisfaction is a subjective measure of how a project satisfies the final user expectations.

	No Impact at All 1	2	3	4	5	6	7	8	Very High Impact 9
Cost Performance	○	○	○	○	○	○	○	○	○
Time Performance	○	○	○	○	○	○	○	○	○
Health and Safety	○	○	○	○	○	○	○	○	○
Environmental Impact and Sustainability	○	○	○	○	○	○	○	○	○
Quality	○	○	○	○	○	○	○	○	○
Functionality	○	○	○	○	○	○	○	○	○
User Satisfaction	○	○	○	○	○	○	○	○	○
Owner Satisfaction	○	○	○	○	○	○	○	○	○

Design Team Satisfaction	○	○	○	○	○	○	○	○	○
Construction Team Satisfaction	○	○	○	○	○	○	○	○	○
Productivity	○	○	○	○	○	○	○	○	○
Claims and Litigation	○	○	○	○	○	○	○	○	○

Impact of "less reliance in contracts" on each of the following performance criteria.
For the purpose of this study:
less reliance in contracts is defined as the ability of the team to interact, collaborate and support the project beyond the contract requirements and constraints.
claims and litigation is measured as economic damages resulting from claims and disputes.
construction team satisfaction is a subjective measure of how the construction team feels when working on the project and how the project fulfills its expectations.
cost performance is measured using the indicators of unit cost, percentage of cost variation relative to the budget, and net present value.
design team satisfaction is a subjective measure of how the design team feels when working on the project and how the project fulfills its expectations.
environmental impact and sustainability is measured using the criteria of the LEED certification or the ISO 14000 standard.
functionality is a subjective measure of how a project fulfills its intended function.
health and safety is measured using the indicator of number of accidents per number of man hours worked on a project
owner satisfaction is a subjective measure of how the owner feels when working on the project, how the project fulfills owner's expectations, and how likely the owner is to work with the same team in future projects.
productivity is a measure of output per unit of input, and is measured as the ratio of square footage per labor hour.
quality is a subjective measure defined as the achievement of features required to satisfy expectations of the owner, and is measured as the extent of meeting specifications.
time performance is measured using the indicators of construction time, speed of construction relative to square footage, and percentage of time variation relative to the schedule.
user satisfaction is a subjective measure of how a project satisfies the final user expectations.

	No Impact at All 1	2	3	4	5	6	7	8	9 Very High Impact
Cost Performance	○	○	○	○	○	○	○	○	○
Time Performance	○	○	○	○	○	○	○	○	○
Health and Safety	○	○	○	○	○	○	○	○	○
Environmental Impact and Sustainability	○	○	○	○	○	○	○	○	○

Quality	○	○	○	○	○	○	○	○	○
Functionality	○	○	○	○	○	○	○	○	○
User Satisfaction	○	○	○	○	○	○	○	○	○
Owner Satisfaction	○	○	○	○	○	○	○	○	○
Design Team Satisfaction	○	○	○	○	○	○	○	○	○
Construction Team Satisfaction	○	○	○	○	○	○	○	○	○
Productivity	○	○	○	○	○	○	○	○	○
Claims and Litigation	○	○	○	○	○	○	○	○	○

Impact of "open book accounting" on each of the following performance criteria.
For the purpose of this study:
open book accounting is defined as having in place a transparent financial structure where all expenses and costs are explicit to team members, helping on building trust between the team, reducing reliance on bidding and contracts themselves, and keeping all team members accountable for their participation in the project.
claims and litigation is measured as economic damages resulting from claims and disputes.
construction team satisfaction is a subjective measure of how the construction team feels when working on the project and how the project fulfills its expectations.
cost performance is measured using the indicators of unit cost, percentage of cost variation relative to the budget, and net present value.
design team satisfaction is a subjective measure of how the design team feels when working on the project and how the project fulfills its expectations.
environmental impact and sustainability is measured using the criteria of the LEED certification or the ISO 14000 standard.
functionality is a subjective measure of how a project fulfills its intended function.
health and safety is measured using the indicator of number of accidents per number of man hours worked on a project
owner satisfaction is a subjective measure of how the owner feels when working on the project, how the project fulfills owner's expectations, and how likely the owner is to work with the same team in future projects.
productivity is a measure of output per unit of input, and is measured as the ratio of square footage per labor hour.
quality is a subjective measure defined as the achievement of features required to satisfy expectations of the owner, and is measured as the extent of meeting specifications.
time performance is measured using the indicators of construction time, speed of construction relative to square footage, and percentage of time variation relative to the schedule.
user satisfaction is a subjective measure of how a project satisfies the final user expectations.

	No Impact at All 1	2	3	4	5	6	7	8	Very High Impact 9
Cost Performance	○	○	○	○	○	○	○	○	○
Time Performance	○	○	○	○	○	○	○	○	○
Health and Safety	○	○	○	○	○	○	○	○	○
Environmental Impact and Sustainability	○	○	○	○	○	○	○	○	○
Quality	○	○	○	○	○	○	○	○	○
Functionality	○	○	○	○	○	○	○	○	○
User Satisfaction	○	○	○	○	○	○	○	○	○
Owner Satisfaction	○	○	○	○	○	○	○	○	○
Design Team Satisfaction	○	○	○	○	○	○	○	○	○
Construction Team Satisfaction	○	○	○	○	○	○	○	○	○
Productivity	○	○	○	○	○	○	○	○	○
Claims and Litigation	○	○	○	○	○	○	○	○	○

Impact of "personal attitude and commitment" on each of the following performance criteria.
For the purpose of this study:
personal attitude and commitment is defined as the individual internal motivation to change processes and to improvement, including a change in attitude, mindset and commitment, by developing personal relationships with their counter parts and understand the motivations of the entire team. These changes are required from every person who is involved in the process at all levels, from the working-level people working at the jobsite on a daily basis to the top management.
claims and litigation is measured as economic damages resulting from claims and disputes.
construction team satisfaction is a subjective measure of how the construction team feels when working on the project and how the project fulfills its expectations.
cost performance is measured using the indicators of unit cost, percentage of cost variation relative to the budget, and net present value.
design team satisfaction is a subjective measure of how the design team feels when working on the project and how the project fulfills its expectations.
environmental impact and sustainability is measured using the criteria of the LEED certification or the ISO 14000 standard.
functionality is a subjective measure of how a project fulfills its intended function.
health and safety is measured using the indicator of number of accidents per number of man hours worked on a project

owner satisfaction is a subjective measure of how the owner feels when working on the project, how the project fulfills owner's expectations, and how likely the owner is to work with the same team in future projects.
productivity is a measure of output per unit of input, and is measured as the ratio of square footage per labor hour.
quality is a subjective measure defined as the achievement of features required to satisfy expectations of the owner, and is measured as the extent of meeting specifications.
time performance is measured using the indicators of construction time, speed of construction relative to square footage, and percentage of time variation relative to the schedule.
user satisfaction is a subjective measure of how a project satisfies the final user expectations.

	No Impact at All								Very High Impact
	1	2	3	4	5	6	7	8	9
Cost Performance	○	○	○	○	○	○	○	○	○
Time Performance	○	○	○	○	○	○	○	○	○
Health and Safety	○	○	○	○	○	○	○	○	○
Environmental Impact and Sustainability	○	○	○	○	○	○	○	○	○
Quality	○	○	○	○	○	○	○	○	○
Functionality	○	○	○	○	○	○	○	○	○
User Satisfaction	○	○	○	○	○	○	○	○	○
Owner Satisfaction	○	○	○	○	○	○	○	○	○
Design Team Satisfaction	○	○	○	○	○	○	○	○	○
Construction Team Satisfaction	○	○	○	○	○	○	○	○	○
Productivity	○	○	○	○	○	○	○	○	○
Claims and Litigation	○	○	○	○	○	○	○	○	○

Impact of "timely responsiveness" on each of the following performance criteria.
For the purpose of this study:
timely responsiveness is defined as having in place a short response time for the inquiries that arise from different parties.
claims and litigation is measured as economic damages resulting from claims and disputes.
construction team satisfaction is a subjective measure of how the construction team feels when working on the project and how the project fulfills its expectations.
cost performance is measured using the indicators of unit cost, percentage of cost variation relative to the budget, and net present value.

design team satisfaction is a subjective measure of how the design team feels when working on the project and how the project fulfills its expectations.
environmental impact and sustainability is measured using the criteria of the LEED certification or the ISO 14000 standard.
functionality is a subjective measure of how a project fulfills its intended function.
health and safety is measured using the indicator of number of accidents per number of man hours worked on a project
owner satisfaction is a subjective measure of how the owner feels when working on the project, how the project fulfills owner's expectations, and how likely the owner is to work with the same team in future projects.
productivity is a measure of output per unit of input, and is measured as the ratio of square footage per labor hour.
quality is a subjective measure defined as the achievement of features required to satisfy expectations of the owner, and is measured as the extent of meeting specifications.
time performance is measured using the indicators of construction time, speed of construction relative to square footage, and percentage of time variation relative to the schedule.
user satisfaction is a subjective measure of how a project satisfies the final user expectations.

	No Impact at All 1	2	3	4	5	6	7	8	Very High Impact 9
Cost Performance	○	○	○	○	○	○	○	○	○
Time Performance	○	○	○	○	○	○	○	○	○
Health and Safety	○	○	○	○	○	○	○	○	○
Environmental Impact and Sustainability	○	○	○	○	○	○	○	○	○
Quality	○	○	○	○	○	○	○	○	○
Functionality	○	○	○	○	○	○	○	○	○
User Satisfaction	○	○	○	○	○	○	○	○	○
Owner Satisfaction	○	○	○	○	○	○	○	○	○
Design Team Satisfaction	○	○	○	○	○	○	○	○	○
Construction Team Satisfaction	○	○	○	○	○	○	○	○	○
Productivity	○	○	○	○	○	○	○	○	○
Claims and Litigation	○	○	○	○	○	○	○	○	○

Impact of "members' company culture" on each of the following performance criteria. For the purpose of this study:

members' company culture is defined as an internal culture of collaboration and teamwork with other companies that each company should have.
claims and litigation is measured as economic damages resulting from claims and disputes.
construction team satisfaction is a subjective measure of how the construction team feels when working on the project and how the project fulfills its expectations.
cost performance is measured using the indicators of unit cost, percentage of cost variation relative to the budget, and net present value.
design team satisfaction is a subjective measure of how the design team feels when working on the project and how the project fulfills its expectations.
environmental impact and sustainability is measured using the criteria of the LEED certification or the ISO 14000 standard.
functionality is a subjective measure of how a project fulfills its intended function.
health and safety is measured using the indicator of number of accidents per number of man hours worked on a project
owner satisfaction is a subjective measure of how the owner feels when working on the project, how the project fulfills owner's expectations, and how likely the owner is to work with the same team in future projects.
productivity is a measure of output per unit of input, and is measured as the ratio of square footage per labor hour.
quality is a subjective measure defined as the achievement of features required to satisfy expectations of the owner, and is measured as the extent of meeting specifications.
time performance is measured using the indicators of construction time, speed of construction relative to square footage, and percentage of time variation relative to the schedule.
user satisfaction is a subjective measure of how a project satisfies the final user expectations.

	No Impact at All 1	2	3	4	5	6	7	8	Very High Impact 9
Cost Performance	○	○	○	○	○	○	○	○	○
Time Performance	○	○	○	○	○	○	○	○	○
Health and Safety	○	○	○	○	○	○	○	○	○
Environmental Impact and Sustainability	○	○	○	○	○	○	○	○	○
Quality	○	○	○	○	○	○	○	○	○
Functionality	○	○	○	○	○	○	○	○	○
User Satisfaction	○	○	○	○	○	○	○	○	○
Owner Satisfaction	○	○	○	○	○	○	○	○	○
Design Team Satisfaction	○	○	○	○	○	○	○	○	○
Construction Team Satisfaction	○	○	○	○	○	○	○	○	○

Productivity	○	○	○	○	○	○	○	○	○
Claims and Litigation	○	○	○	○	○	○	○	○	○

Impact of "team experience" on each of the following performance criteria.
For the purpose of this study:
team experience is defined as the experience of the team and each individual in project integration.
claims and litigation is measured as economic damages resulting from claims and disputes.
construction team satisfaction is a subjective measure of how the construction team feels when working on the project and how the project fulfills its expectations.
cost performance is measured using the indicators of unit cost, percentage of cost variation relative to the budget, and net present value.
design team satisfaction is a subjective measure of how the design team feels when working on the project and how the project fulfills its expectations.
environmental impact and sustainability is measured using the criteria of the LEED certification or the ISO 14000 standard.
functionality is a subjective measure of how a project fulfills its intended function.
health and safety is measured using the indicator of number of accidents per number of man hours worked on a project
owner satisfaction is a subjective measure of how the owner feels when working on the project, how the project fulfills owner's expectations, and how likely the owner is to work with the same team in future projects.
productivity is a measure of output per unit of input, and is measured as the ratio of square footage per labor hour.
quality is a subjective measure defined as the achievement of features required to satisfy expectations of the owner, and is measured as the extent of meeting specifications.
time performance is measured using the indicators of construction time, speed of construction relative to square footage, and percentage of time variation relative to the schedule.
user satisfaction is a subjective measure of how a project satisfies the final user expectations.

	No Impact at All 1	2	3	4	5	6	7	8	Very High Impact 9
Cost Performance	○	○	○	○	○	○	○	○	○
Time Performance	○	○	○	○	○	○	○	○	○
Health and Safety	○	○	○	○	○	○	○	○	○
Environmental Impact and Sustainability	○	○	○	○	○	○	○	○	○
Quality	○	○	○	○	○	○	○	○	○
Functionality	○	○	○	○	○	○	○	○	○

User Satisfaction	○	○	○	○	○	○	○	○	○
Owner Satisfaction	○	○	○	○	○	○	○	○	○
Design Team Satisfaction	○	○	○	○	○	○	○	○	○
Construction Team Satisfaction	○	○	○	○	○	○	○	○	○
Productivity	○	○	○	○	○	○	○	○	○
Claims and Litigation	○	○	○	○	○	○	○	○	○

APPENDIX D

THURSTONE'S SUCCESSIVE INTERVAL PROCEDUREFOR THE NINE RATING CATEGORIES FOR THE COMPLETE GROUP OF RESPONDENTS

Table 41- Matrix of proportions for the complete group of respondents, nine rating categories

Matrix Of Proportions
PROP

	r1	r2	r3	r4	r5	r6	r7	r8	r9
s1	0.01	0.00	0.02	0.03	0.07	0.19	0.26	0.20	0.22
s2	0.00	0.00	0.00	0.01	0.06	0.17	0.28	0.27	0.20
s3	0.00	0.00	0.03	0.02	0.09	0.13	0.31	0.22	0.19
s4	0.00	0.00	0.00	0.02	0.03	0.07	0.26	0.26	0.35
s5	0.00	0.01	0.00	0.01	0.04	0.05	0.17	0.32	0.39
s6	0.00	0.03	0.04	0.03	0.10	0.19	0.25	0.19	0.17
s7	0.00	0.00	0.02	0.06	0.08	0.12	0.28	0.22	0.21
s8	0.00	0.01	0.01	0.04	0.11	0.18	0.20	0.22	0.22
s9	0.00	0.00	0.01	0.00	0.03	0.06	0.15	0.29	0.45
s10	0.00	0.00	0.02	0.03	0.10	0.15	0.22	0.28	0.20
s11	0.00	0.00	0.01	0.02	0.04	0.08	0.30	0.27	0.28
s12	0.01	0.00	0.02	0.03	0.06	0.13	0.26	0.28	0.22
s13	0.00	0.00	0.02	0.04	0.04	0.15	0.22	0.27	0.27
s14	0.00	0.00	0.01	0.01	0.04	0.12	0.17	0.31	0.33
s15	0.01	0.02	0.02	0.06	0.17	0.17	0.26	0.18	0.11
s16	0.00	0.00	0.02	0.04	0.08	0.18	0.24	0.24	0.20
s17	0.01	0.02	0.03	0.05	0.08	0.19	0.24	0.23	0.16
s18	0.01	0.01	0.02	0.03	0.10	0.15	0.20	0.28	0.21
s19	0.00	0.00	0.00	0.01	0.04	0.05	0.22	0.32	0.36
s20	0.05	0.06	0.11	0.09	0.15	0.17	0.20	0.09	0.08
s21	0.00	0.00	0.00	0.00	0.02	0.06	0.13	0.28	0.51
s22	0.00	0.00	0.02	0.04	0.09	0.20	0.28	0.24	0.13
s23	0.00	0.00	0.00	0.01	0.02	0.04	0.15	0.33	0.44
s24	0.00	0.00	0.00	0.01	0.00	0.06	0.17	0.33	0.41
s25	0.00	0.00	0.03	0.04	0.11	0.15	0.29	0.22	0.16
s26	0.00	0.00	0.01	0.01	0.06	0.08	0.23	0.28	0.33
s27	0.01	0.02	0.09	0.06	0.15	0.13	0.20	0.19	0.14
s28	0.00	0.01	0.00	0.03	0.06	0.11	0.17	0.31	0.30
s29	0.00	0.01	0.00	0.01	0.03	0.09	0.22	0.31	0.33
s30	0.00	0.01	0.03	0.01	0.06	0.10	0.29	0.22	0.28
s31	0.06	0.05	0.10	0.10	0.16	0.16	0.16	0.13	0.09
s32	0.00	0.02	0.03	0.04	0.11	0.14	0.26	0.21	0.19
s33	0.00	0.00	0.01	0.00	0.02	0.06	0.27	0.30	0.34
s34	0.00	0.00	0.01	0.01	0.05	0.10	0.18	0.30	0.35
s35	0.01	0.02	0.04	0.06	0.11	0.13	0.22	0.22	0.20
s36	0.00	0.01	0.00	0.02	0.02	0.09	0.17	0.34	0.34
s37	0.00	0.00	0.00	0.02	0.05	0.16	0.28	0.29	0.21
s38	0.00	0.01	0.01	0.02	0.06	0.15	0.32	0.21	0.22
s39	0.02	0.01	0.03	0.04	0.09	0.16	0.24	0.23	0.18
s40	0.06	0.04	0.04	0.06	0.15	0.15	0.18	0.20	0.13
s41	0.03	0.03	0.08	0.07	0.16	0.18	0.21	0.09	0.15
s42	0.00	0.01	0.00	0.01	0.03	0.09	0.17	0.33	0.35
s43	0.00	0.00	0.01	0.00	0.01	0.07	0.18	0.33	0.39
s44	0.01	0.01	0.03	0.03	0.09	0.15	0.27	0.21	0.20
s45	0.00	0.01	0.00	0.03	0.08	0.16	0.28	0.27	0.16

Table 42- Matrix of cumulative proportions for the complete group of respondents, nine rating categories

Matrix Of Cumulative Proportions

CUMPROP

	r1	r2	r3	r4	r5	r6	r7	r8	r9
s1	0.009	0.014	0.032	0.064	0.133	0.321	0.583	0.784	1.000
s2	0.005	0.005	0.009	0.023	0.078	0.243	0.528	0.798	1.000
s3	0.005	0.009	0.037	0.055	0.142	0.271	0.583	0.807	1.000
s4	0.000	0.000	0.000	0.023	0.055	0.128	0.385	0.647	1.000
s5	0.000	0.009	0.009	0.023	0.064	0.115	0.289	0.610	1.000
s6	0.005	0.032	0.069	0.096	0.197	0.385	0.638	0.826	1.000
s7	0.005	0.009	0.028	0.083	0.161	0.284	0.569	0.794	1.000
s8	0.000	0.009	0.023	0.060	0.174	0.353	0.555	0.775	1.000
s9	0.000	0.005	0.014	0.018	0.050	0.110	0.257	0.546	1.000
s10	0.005	0.005	0.028	0.060	0.156	0.303	0.523	0.798	1.000
s11	0.005	0.005	0.014	0.032	0.073	0.151	0.450	0.720	1.000
s12	0.009	0.014	0.032	0.060	0.124	0.252	0.509	0.784	1.000
s13	0.000	0.005	0.023	0.060	0.101	0.248	0.463	0.729	1.000
s14	0.000	0.000	0.009	0.023	0.064	0.188	0.358	0.670	1.000
s15	0.014	0.037	0.060	0.119	0.284	0.450	0.706	0.885	1.000
s16	0.000	0.005	0.028	0.064	0.142	0.321	0.560	0.798	1.000
s17	0.014	0.032	0.060	0.106	0.183	0.372	0.610	0.844	1.000
s18	0.009	0.018	0.041	0.073	0.170	0.317	0.514	0.789	1.000
s19	0.000	0.000	0.000	0.014	0.050	0.101	0.321	0.638	1.000
s20	0.046	0.106	0.216	0.303	0.454	0.628	0.830	0.917	1.000
s21	0.000	0.005	0.005	0.005	0.028	0.087	0.216	0.491	1.000
s22	0.005	0.005	0.023	0.064	0.156	0.353	0.633	0.872	1.000
s23	0.005	0.005	0.005	0.018	0.041	0.083	0.234	0.564	1.000
s24	0.000	0.005	0.009	0.023	0.028	0.092	0.261	0.587	1.000
s25	0.000	0.005	0.032	0.073	0.183	0.335	0.624	0.839	1.000
s26	0.000	0.005	0.014	0.028	0.083	0.161	0.390	0.674	1.000
s27	0.014	0.037	0.124	0.188	0.339	0.468	0.670	0.858	1.000
s28	0.000	0.009	0.014	0.041	0.106	0.216	0.390	0.702	1.000
s29	0.000	0.009	0.009	0.018	0.050	0.142	0.358	0.670	1.000
s30	0.000	0.014	0.046	0.060	0.115	0.216	0.505	0.725	1.000
s31	0.055	0.106	0.206	0.307	0.463	0.619	0.775	0.908	1.000
s32	0.005	0.023	0.055	0.092	0.202	0.344	0.601	0.807	1.000
s33	0.000	0.000	0.009	0.009	0.028	0.092	0.358	0.656	1.000
s34	0.000	0.005	0.014	0.023	0.069	0.170	0.349	0.651	1.000
s35	0.009	0.032	0.069	0.133	0.239	0.367	0.583	0.803	1.000
s36	0.000	0.009	0.014	0.032	0.055	0.142	0.312	0.656	1.000
s37	0.005	0.005	0.005	0.023	0.069	0.229	0.505	0.794	1.000
s38	0.000	0.009	0.023	0.041	0.106	0.252	0.573	0.784	1.000
s39	0.018	0.032	0.060	0.096	0.188	0.344	0.583	0.817	1.000
s40	0.060	0.096	0.133	0.193	0.344	0.491	0.674	0.872	1.000
s41	0.028	0.060	0.142	0.211	0.367	0.550	0.761	0.853	1.000
s42	0.005	0.014	0.014	0.028	0.060	0.151	0.317	0.647	1.000
s43	0.000	0.000	0.009	0.014	0.028	0.101	0.280	0.615	1.000
s44	0.009	0.023	0.050	0.078	0.170	0.317	0.587	0.798	1.000
s45	0.005	0.018	0.023	0.055	0.133	0.289	0.569	0.839	1.000

Table 43- Matrix of probits for the complete group of respondents, nine rating categories

Matrix Of Probits (Z-scores)

PROBITS

	r1	r2	r3	r4	r5	r6	r7	r8
s1	.	.	.	-1.52	-1.11	-.465	0.208	0.787
s2	.	.	.	.	-1.42	-.696	0.069	0.835
s3	.	.	.	-1.60	-1.07	-.611	0.208	0.868
s4	.	.	.	.	-1.60	-1.13	-.292	0.377
s5	.	.	.	.	-1.52	-1.20	-.556	0.280
s6	.	.	-1.48	-1.30	-.851	-.292	0.352	0.937
s7	.	.	.	-1.39	-.992	-.570	0.173	0.819
s8	.	.	.	-1.56	-.937	-.377	0.138	0.756
s9	.	.	.	.	-1.64	-1.23	-.653	0.115
s10	.	.	.	-1.56	-1.01	-.517	0.058	0.835
s11	.	.	.	.	-1.45	-1.03	-.127	0.583
s12	.	.	.	-1.56	-1.16	-.667	0.023	0.787
s13	.	.	.	-1.56	-1.28	-.682	-.092	0.611
s14	.	.	.	.	-1.52	-.885	-.364	0.439
s15	.	.	-1.56	-1.18	-.570	-.127	0.543	1.202
s16	.	.	.	-1.52	-1.07	-.465	0.150	0.835
s17	.	.	-1.56	-1.25	-.902	-.328	0.280	1.011
s18	.	.	.	-1.45	-.955	-.477	0.035	0.803
s19	.	.	.	.	-1.64	-1.28	-.465	0.352
s20	.	-1.25	-.787	-.517	-.115	0.328	0.955	1.388
s21	.	.	.	.	.	-1.36	-.787	-.023
s22	.	.	.	-1.52	-1.01	-.377	0.340	1.134
s23	.	.	.	.	.	-1.39	-.726	0.162
s24	.	.	.	.	.	-1.33	-.639	0.220
s25	.	.	.	-1.45	-.902	-.427	0.316	0.992
s26	.	.	.	.	-1.39	-.992	-.280	0.452
s27	.	.	-1.16	-.885	-.414	-.081	0.439	1.070
s28	.	.	.	.	-1.25	-.787	-.280	0.530
s29	.	.	.	.	-1.64	-1.07	-.364	0.439
s30	.	.	.	-1.56	-1.20	-.787	0.011	0.597
s31	-1.60	-1.25	-.819	-.503	-.092	0.304	0.756	1.330
s32	.	.	-1.60	-1.33	-.835	-.401	0.256	0.868
s33	.	.	.	.	.	-1.33	-.364	0.401
s34	.	.	.	.	-1.48	-.955	-.389	0.389
s35	.	.	-1.48	-1.11	-.711	-.340	0.208	0.851
s36	.	.	.	.	-1.60	-1.07	-.490	0.401
s37	.	.	.	.	-1.48	-.741	0.011	0.819
s38	.	.	.	.	-1.25	-.667	0.185	0.787
s39	.	.	-1.56	-1.30	-.885	-.401	0.208	0.902
s40	-1.56	-1.30	-1.11	-.868	-.401	-.023	0.452	1.134
s41	.	-1.56	-1.07	-.803	-.340	0.127	0.711	1.050
s42	.	.	.	.	-1.56	-1.03	-.477	0.377
s43	.	.	.	.	.	-1.28	-.583	0.292
s44	.	.	-1.64	-1.42	-.955	-.477	0.220	0.835
s45	.	.	.	-1.60	-1.11	-.556	0.173	0.992

Table 44- Matrix of approbits for the complete group of respondents, nine rating categories

Matrix Of Probit Differences	APROBITS	r1	r2	r3	r4	r5	r6	r7
	s1	.	.	.	0.41	0.65	0.67	0.58
	s2	.	.	.	.	0.72	0.77	0.77
	s3	.	.	.	0.53	0.46	0.82	0.66
	s4	.	.	.	.	0.46	0.84	0.67
	s5	.	.	.	.	0.32	0.65	0.84
	s6	.	.	0.18	0.45	0.56	0.64	0.59
	s7	.	.	.	0.40	0.42	0.74	0.65
	s8	.	.	.	0.62	0.56	0.52	0.62
	s9	.	.	.	.	0.41	0.57	0.77
	s10	.	.	.	0.55	0.49	0.57	0.78
	s11	.	.	.	.	0.42	0.90	0.71
	s12	.	.	.	0.40	0.49	0.69	0.76
	s13	.	.	.	0.28	0.59	0.59	0.70
	s14	.	.	.	.	0.64	0.52	0.80
	s15	.	.	0.38	0.61	0.44	0.67	0.66
	s16	.	.	.	0.45	0.61	0.61	0.69
	s17	.	.	0.31	0.35	0.57	0.61	0.73
	s18	.	.	.	0.50	0.48	0.51	0.77
	s19	.	.	.	.	0.36	0.81	0.82
	s20	.	0.46	0.27	0.40	0.44	0.63	0.43
	s21	.	.	.	.	.	0.57	0.76
	s22	.	.	.	0.51	0.63	0.72	0.79
	s23	.	.	.	.	.	0.66	0.89
	s24	.	.	.	.	.	0.69	0.86
	s25	.	.	.	0.55	0.48	0.74	0.68
	s26	.	.	.	.	0.40	0.71	0.73
	s27	.	.	0.27	0.47	0.33	0.52	0.63
	s28	.	.	.	.	0.46	0.51	0.81
	s29	.	.	.	.	0.57	0.71	0.80
	s30	.	.	.	0.36	0.41	0.80	0.59
	s31	0.35	0.43	0.32	0.41	0.40	0.45	0.57
	s32	.	.	0.27	0.50	0.43	0.66	0.61
	s33	.	.	.	.	.	0.97	0.77
	s34	.	.	.	.	0.53	0.57	0.78
	s35	.	.	0.37	0.40	0.37	0.55	0.64
	s36	.	.	.	.	0.53	0.58	0.89
	s37	.	.	.	.	0.74	0.75	0.81
	s38	.	.	.	.	0.58	0.85	0.60
	s39	.	.	0.26	0.42	0.48	0.61	0.69
	s40	0.26	0.19	0.24	0.47	0.38	0.47	0.68
	s41	.	0.49	0.27	0.46	0.47	0.58	0.34
	s42	.	.	.	.	0.53	0.55	0.85
	s43	.	.	.	.	.	0.69	0.87
	s44	.	.	0.22	0.46	0.48	0.70	0.61
	s45	.	.	.	0.49	0.56	0.73	0.82

Table 45- Category boundaries for the complete group of respondents, nine rating categories

Category Boundaries

CATBOUND

r1	r2	r3	r4	r5	r6	r7	r8
0.000	1.000	2.070	2.765	3.847	4.968	6.390	7.882

Table 46- Scale values complete for the group of respondents, nine rating categories

Scale Values

	SCALE
s1	6.077
s2	6.318
s3	6.075
s4	7.093
s5	7.436
s6	5.675
s7	6.063
s8	6.062
s9	7.735
s10	6.127
s11	6.746
s12	6.285
s13	6.553
s14	7.005
s15	5.252
s16	6.063
s17	5.693
s18	6.121
s19	7.271
s20	4.131
s21	7.989
s22	5.721
s23	7.636
s24	7.508
s25	5.786
s26	6.965
s27	5.108
s28	6.802
s29	7.055
s30	6.524
s31	4.245
s32	5.840
s33	7.139
s34	7.104
s35	5.761
s36	7.185
s37	6.389
s38	6.232
s39	5.848
s40	4.954
s41	4.824
s42	7.199
s43	7.384
s44	5.972
s45	5.999

Table 47- Standard deviations of the discriminal process distribution of the attributes for the complete group of respondents, nine rating categories

Stimulus STDs

	SCALESTD
s1	2.157
s2	1.803
s3	2.054
s4	1.996
s5	2.220
s6	2.320
s7	2.281
s8	2.254
s9	2.307
s10	2.182
s11	1.924
s12	2.168
s13	2.306
s14	2.117
s15	2.125
s16	2.156
s17	2.270
s18	2.322
s19	1.980
s20	2.578
s21	2.180
s22	1.918
s23	1.878
s24	1.878
s25	2.093
s26	2.161
s27	2.660
s28	2.305
s29	1.946
s30	2.303
s31	2.688
s32	2.341
s33	1.685
s34	2.184
s35	2.568
s36	2.050
s37	1.770
s38	1.946
s39	2.361
s40	2.909
s41	2.575
s42	2.123
s43	1.857
s44	2.301
s45	1.971

Table 48- Difference between reproduced and original proportions for the complete group of respondents, nine rating categories

Difference Between Reproduced And Original Proportions
THURST

	r1	r2	r3	r4	r5	r6	r7	r8
s1	0.007	0.004	0.001	0.002	0.018	0.017	0.025	0.014
s2	0.004	0.003	0.000	0.001	0.007	0.016	0.011	0.009
s3	0.003	0.002	0.011	0.002	0.003	0.024	0.022	0.003
s4	0.000	0.001	0.006	0.008	0.003	0.015	0.023	0.007
s5	0.000	0.007	0.001	0.005	0.011	0.018	0.030	0.031
s6	0.003	0.010	0.009	0.009	0.018	0.005	0.017	0.004
s7	0.001	0.004	0.012	0.009	0.005	0.031	0.012	0.006
s8	0.004	0.003	0.015	0.012	0.011	0.039	0.003	0.015
s9	0.000	0.003	0.007	0.003	0.005	0.005	0.023	0.020
s10	0.002	0.005	0.004	0.002	0.008	0.005	0.025	0.009
s11	0.004	0.003	0.006	0.013	0.007	0.026	0.023	0.002
s12	0.007	0.006	0.006	0.007	0.006	0.019	0.010	0.015
s13	0.002	0.003	0.003	0.009	0.019	0.002	0.009	0.012
s14	0.000	0.002	0.001	0.000	0.004	0.020	0.028	0.009
s15	0.007	0.014	0.008	0.002	0.030	0.003	0.003	0.007
s16	0.002	0.005	0.004	0.001	0.010	0.015	0.001	0.002
s17	0.008	0.013	0.004	0.007	0.025	0.003	0.010	0.012
s18	0.005	0.005	0.001	0.001	0.006	0.007	0.032	0.013
s19	0.000	0.001	0.004	0.002	0.009	0.021	0.007	0.017
s20	0.009	0.007	0.004	0.005	0.002	0.001	0.021	0.010
s21	0.000	0.004	0.001	0.004	0.001	0.004	0.016	0.010
s22	0.003	0.002	0.006	0.003	0.008	0.006	0.003	0.001
s23	0.005	0.004	0.003	0.014	0.019	0.005	0.020	0.012
s24	0.000	0.004	0.007	0.017	0.002	0.004	0.014	0.008
s25	0.003	0.007	0.006	0.001	0.006	0.013	0.010	0.002
s26	0.001	0.002	0.002	0.002	0.008	0.017	0.005	0.010
s27	0.014	0.025	0.003	0.001	0.022	0.011	0.015	0.006
s28	0.002	0.003	0.006	0.001	0.006	0.002	0.039	0.022
s29	0.000	0.008	0.004	0.005	0.001	0.000	0.009	0.005
s30	0.002	0.006	0.019	0.008	0.008	0.034	0.028	0.002
s31	0.002	0.008	0.003	0.016	0.022	0.013	0.012	0.004
s32	0.002	0.004	0.001	0.003	0.005	0.011	0.008	0.001
s33	0.000	0.000	0.008	0.004	0.002	0.007	0.030	0.014
s34	0.001	0.002	0.003	0.001	0.001	0.006	0.023	0.012
s35	0.003	0.000	0.006	0.011	0.011	0.012	0.014	0.007
s36	0.000	0.008	0.007	0.017	0.003	0.002	0.037	0.023
s37	0.004	0.003	0.003	0.003	0.007	0.018	0.004	0.007
s38	0.001	0.006	0.007	0.004	0.005	0.006	0.041	0.017
s39	0.012	0.012	0.005	0.001	0.010	0.011	0.008	0.011
s40	0.015	0.009	0.028	0.033	0.008	0.011	0.015	0.029
s41	0.003	0.009	0.000	0.001	0.015	0.028	0.033	0.029
s42	0.004	0.012	0.006	0.009	0.002	0.005	0.035	0.021
s43	0.000	0.000	0.007	0.007	0.001	0.004	0.016	0.009
s44	0.004	0.008	0.005	0.004	0.008	0.015	0.015	0.001
s45	0.003	0.013	0.000	0.005	0.004	0.012	0.010	0.009

Table 49- Absolute difference between reproduced and original proportions for the complete group of respondents, nine rating categories

Absolute Difference Between Reproduced And Original Proportions
Averaged Across Categories
THURST

	r1
s1	0.011
s2	0.007
s3	0.009
s4	0.008
s5	0.013
s6	0.009
s7	0.010
s8	0.013
s9	0.008
s10	0.007
s11	0.011
s12	0.010
s13	0.007
s14	0.008
s15	0.009
s16	0.005
s17	0.010
s18	0.009
s19	0.008
s20	0.007
s21	0.005
s22	0.004
s23	0.010
s24	0.007
s25	0.006
s26	0.006
s27	0.012
s28	0.010
s29	0.004
s30	0.013
s31	0.010
s32	0.004
s33	0.008
s34	0.006
s35	0.008
s36	0.012
s37	0.006
s38	0.011
s39	0.009
s40	0.019
s41	0.015
s42	0.012
s43	0.006
s44	0.008
s45	0.007

APPENDIX E

THURSTONE'S SUCCESSIVE INTERVAL PROCEDURE FOR SIX RATING CATEGORIES FOR THE COMPLETE GROUP OF RESPONDENTS

Table 50-Observed frequencies for the complete group of respondents, six rating categories

Obs	stimulus	_1	_2	_3	_4	_5	_6
1	1	14	15	41	57	44	47
2	2	5	12	36	62	59	44
3	3	12	19	28	68	49	42
4	4	5	7	16	56	57	77
5	5	5	9	11	38	70	85
6	6	21	22	41	55	41	38
7	7	18	17	27	62	49	45
8	8	13	25	39	44	48	49
9	9	4	7	13	32	63	99
10	10	13	21	32	48	60	44
11	11	7	9	17	65	59	61
12	12	13	14	28	56	60	47
13	13	13	9	32	47	58	59
14	14	5	9	27	37	68	72
15	15	26	36	36	56	39	25
16	16	14	17	39	52	52	44
17	17	23	17	41	52	51	34
18	18	16	21	32	43	60	46
19	19	3	8	11	48	69	79
20	20	66	33	38	44	19	18
21	21	1	5	13	28	60	111
22	22	14	20	43	61	52	28
23	23	4	5	9	33	72	95
24	24	5	1	14	37	71	90
25	25	16	24	33	63	47	35
26	26	6	12	17	50	62	71
27	27	41	33	28	44	41	31
28	28	9	14	24	38	68	65
29	29	4	7	20	47	68	72
30	30	13	12	22	63	48	60
31	31	67	34	34	34	29	20
32	32	20	24	31	56	45	42
33	33	2	4	14	58	65	75
34	34	5	10	22	39	66	76
35	35	29	23	28	47	48	43
36	36	7	5	19	37	75	75
37	37	5	10	35	60	63	45
38	38	9	14	32	70	46	47
39	39	21	20	34	52	51	40
40	40	42	33	32	40	43	28
41	41	46	34	40	46	20	32
42	42	6	7	20	36	72	77
43	43	3	3	16	39	73	84
44	44	17	20	32	59	46	44
45	45	12	17	34	61	59	35

Table 51-Matrix of proportions for the complete group of respondents, six rating categories

Matrix Of Proportions

PROP

	r1	r2	r3	r4	r5	r6
s1	0.06	0.07	0.19	0.26	0.20	0.22
s2	0.02	0.06	0.17	0.28	0.27	0.20
s3	0.06	0.09	0.13	0.31	0.22	0.19
s4	0.02	0.03	0.07	0.26	0.26	0.35
s5	0.02	0.04	0.05	0.17	0.32	0.39
s6	0.10	0.10	0.19	0.25	0.19	0.17
s7	0.08	0.08	0.12	0.28	0.22	0.21
s8	0.06	0.11	0.18	0.20	0.22	0.22
s9	0.02	0.03	0.06	0.15	0.29	0.45
s10	0.06	0.10	0.15	0.22	0.28	0.20
s11	0.03	0.04	0.08	0.30	0.27	0.28
s12	0.06	0.06	0.13	0.26	0.28	0.22
s13	0.06	0.04	0.15	0.22	0.27	0.27
s14	0.02	0.04	0.12	0.17	0.31	0.33
s15	0.12	0.17	0.17	0.26	0.18	0.11
s16	0.06	0.08	0.18	0.24	0.24	0.20
s17	0.11	0.08	0.19	0.24	0.23	0.16
s18	0.07	0.10	0.15	0.20	0.28	0.21
s19	0.01	0.04	0.05	0.22	0.32	0.36
s20	0.30	0.15	0.17	0.20	0.09	0.08
s21	0.00	0.02	0.06	0.13	0.28	0.51
s22	0.06	0.09	0.20	0.28	0.24	0.13
s23	0.02	0.02	0.04	0.15	0.33	0.44
s24	0.02	0.00	0.06	0.17	0.33	0.41
s25	0.07	0.11	0.15	0.29	0.22	0.16
s26	0.03	0.06	0.08	0.23	0.28	0.33
s27	0.19	0.15	0.13	0.20	0.19	0.14
s28	0.04	0.06	0.11	0.17	0.31	0.30
s29	0.02	0.03	0.09	0.22	0.31	0.33
s30	0.06	0.06	0.10	0.29	0.22	0.28
s31	0.31	0.16	0.16	0.16	0.13	0.09
s32	0.09	0.11	0.14	0.26	0.21	0.19
s33	0.01	0.02	0.06	0.27	0.30	0.34
s34	0.02	0.05	0.10	0.18	0.30	0.35
s35	0.13	0.11	0.13	0.22	0.22	0.20
s36	0.03	0.02	0.09	0.17	0.34	0.34
s37	0.02	0.05	0.16	0.28	0.29	0.21
s38	0.04	0.06	0.15	0.32	0.21	0.22
s39	0.10	0.09	0.16	0.24	0.23	0.18
s40	0.19	0.15	0.15	0.18	0.20	0.13
s41	0.21	0.16	0.18	0.21	0.09	0.15
s42	0.03	0.03	0.09	0.17	0.33	0.35
s43	0.01	0.01	0.07	0.18	0.33	0.39
s44	0.08	0.09	0.15	0.27	0.21	0.20
s45	0.06	0.08	0.16	0.28	0.27	0.16

Table 52- Matrix of cumulative proportions for the complete group of respondents, six rating categories

Matrix Of Cumulative Proportions

CUMPROP

	r1	r2	r3	r4	r5	r6
s1	0.064	0.133	0.321	0.583	0.784	1.000
s2	0.023	0.078	0.243	0.528	0.798	1.000
s3	0.055	0.142	0.271	0.583	0.807	1.000
s4	0.023	0.055	0.128	0.385	0.647	1.000
s5	0.023	0.064	0.115	0.289	0.610	1.000
s6	0.096	0.197	0.385	0.638	0.826	1.000
s7	0.083	0.161	0.284	0.569	0.794	1.000
s8	0.060	0.174	0.353	0.555	0.775	1.000
s9	0.018	0.050	0.110	0.257	0.546	1.000
s10	0.060	0.156	0.303	0.523	0.798	1.000
s11	0.032	0.073	0.151	0.450	0.720	1.000
s12	0.060	0.124	0.252	0.509	0.784	1.000
s13	0.060	0.101	0.248	0.463	0.729	1.000
s14	0.023	0.064	0.188	0.358	0.670	1.000
s15	0.119	0.284	0.450	0.706	0.885	1.000
s16	0.064	0.142	0.321	0.560	0.798	1.000
s17	0.106	0.183	0.372	0.610	0.844	1.000
s18	0.073	0.170	0.317	0.514	0.789	1.000
s19	0.014	0.050	0.101	0.321	0.638	1.000
s20	0.303	0.454	0.628	0.830	0.917	1.000
s21	0.005	0.028	0.087	0.216	0.491	1.000
s22	0.064	0.156	0.353	0.633	0.872	1.000
s23	0.018	0.041	0.083	0.234	0.564	1.000
s24	0.023	0.028	0.092	0.261	0.587	1.000
s25	0.073	0.183	0.335	0.624	0.839	1.000
s26	0.028	0.083	0.161	0.390	0.674	1.000
s27	0.188	0.339	0.468	0.670	0.858	1.000
s28	0.041	0.106	0.216	0.390	0.702	1.000
s29	0.018	0.050	0.142	0.358	0.670	1.000
s30	0.060	0.115	0.216	0.505	0.725	1.000
s31	0.307	0.463	0.619	0.775	0.908	1.000
s32	0.092	0.202	0.344	0.601	0.807	1.000
s33	0.009	0.028	0.092	0.358	0.656	1.000
s34	0.023	0.069	0.170	0.349	0.651	1.000
s35	0.133	0.239	0.367	0.583	0.803	1.000
s36	0.032	0.055	0.142	0.312	0.656	1.000
s37	0.023	0.069	0.229	0.505	0.794	1.000
s38	0.041	0.106	0.252	0.573	0.784	1.000
s39	0.096	0.188	0.344	0.583	0.817	1.000
s40	0.193	0.344	0.491	0.674	0.872	1.000
s41	0.211	0.367	0.550	0.761	0.853	1.000
s42	0.028	0.060	0.151	0.317	0.647	1.000
s43	0.014	0.028	0.101	0.280	0.615	1.000
s44	0.078	0.170	0.317	0.587	0.798	1.000
s45	0.055	0.133	0.289	0.569	0.839	1.000

Table 53- Matrix of probits for the complete group of respondents, six rating categories

Matrix Of Probits (Z-scores)

PROBITS

	r1	r2	r3	r4	r5
s1	-1.52	-1.11	-.465	0.208	0.787
s2	.	-1.42	-.696	0.069	0.835
s3	-1.60	-1.07	-.611	0.208	0.868
s4	.	-1.60	-1.13	-.292	0.377
s5	.	-1.52	-1.20	-.556	0.280
s6	-1.30	-.851	-.292	0.352	0.937
s7	-1.39	-.992	-.570	0.173	0.819
s8	-1.56	-.937	-.377	0.138	0.756
s9	.	-1.64	-1.23	-.653	0.115
s10	-1.56	-1.01	-.517	0.058	0.835
s11	.	-1.45	-1.03	-.127	0.583
s12	-1.56	-1.16	-.667	0.023	0.787
s13	-1.56	-1.28	-.682	-.092	0.611
s14	.	-1.52	-.885	-.364	0.439
s15	-1.18	-.570	-.127	0.543	1.202
s16	-1.52	-1.07	-.465	0.150	0.835
s17	-1.25	-.902	-.328	0.280	1.011
s18	-1.45	-.955	-.477	0.035	0.803
s19	.	-1.64	-1.28	-.465	0.352
s20	-.517	-.115	0.328	0.955	1.388
s21	.	.	-1.36	-.787	-.023
s22	-1.52	-1.01	-.377	0.340	1.134
s23	.	.	-1.39	-.726	0.162
s24	.	.	-1.33	-.639	0.220
s25	-1.45	-.902	-.427	0.316	0.992
s26	.	-1.39	-.992	-.280	0.452
s27	-.885	-.414	-.081	0.439	1.070
s28	.	-1.25	-.787	-.280	0.530
s29	.	-1.64	-1.07	-.364	0.439
s30	-1.56	-1.20	-.787	0.011	0.597
s31	-.503	-.092	0.304	0.756	1.330
s32	-1.33	-.835	-.401	0.256	0.868
s33	.	.	-1.33	-.364	0.401
s34	.	-1.48	-.955	-.389	0.389
s35	-1.11	-.711	-.340	0.208	0.851
s36	.	-1.60	-1.07	-.490	0.401
s37	.	-1.48	-.741	0.011	0.819
s38	.	-1.25	-.667	0.185	0.787
s39	-1.30	-.885	-.401	0.208	0.902
s40	-.868	-.401	-.023	0.452	1.134
s41	-.803	-.340	0.127	0.711	1.050
s42	.	-1.56	-1.03	-.477	0.377
s43	.	.	-1.28	-.583	0.292
s44	-1.42	-.955	-.477	0.220	0.835
s45	-1.60	-1.11	-.556	0.173	0.992

Table 54- Matrix of approbits for the complete group of respondents, six rating categories

	APROBITS	r1	r2	r3	r4
Matrix Of Probit Differences	s1	0.41	0.65	0.67	0.58
	s2	.	0.72	0.77	0.77
	s3	0.53	0.46	0.82	0.66
	s4	.	0.46	0.84	0.67
	s5	.	0.32	0.65	0.84
	s6	0.45	0.56	0.64	0.59
	s7	0.40	0.42	0.74	0.65
	s8	0.62	0.56	0.52	0.62
	s9	.	0.41	0.57	0.77
	s10	0.55	0.49	0.57	0.78
	s11	.	0.42	0.90	0.71
	s12	0.40	0.49	0.69	0.76
	s13	0.28	0.59	0.59	0.70
	s14	.	0.64	0.52	0.80
	s15	0.61	0.44	0.67	0.66
	s16	0.45	0.61	0.61	0.69
	s17	0.35	0.57	0.61	0.73
	s18	0.50	0.48	0.51	0.77
	s19	.	0.36	0.81	0.82
	s20	0.40	0.44	0.63	0.43
	s21	.	.	0.57	0.76
	s22	0.51	0.63	0.72	0.79
	s23	.	.	0.66	0.89
	s24	.	.	0.69	0.86
	s25	0.55	0.48	0.74	0.68
	s26	.	0.40	0.71	0.73
	s27	0.47	0.33	0.52	0.63
	s28	.	0.46	0.51	0.81
	s29	.	0.57	0.71	0.80
	s30	0.36	0.41	0.80	0.59
	s31	0.41	0.40	0.45	0.57
	s32	0.50	0.43	0.66	0.61
	s33	.	.	0.97	0.77
	s34	.	0.53	0.57	0.78
	s35	0.40	0.37	0.55	0.64
	s36	.	0.53	0.58	0.89
	s37	.	0.74	0.75	0.81
	s38	.	0.58	0.85	0.60
	s39	0.42	0.48	0.61	0.69
	s40	0.47	0.38	0.47	0.68
	s41	0.46	0.47	0.58	0.34
	s42	.	0.53	0.55	0.85
	s43	.	.	0.69	0.87
	s44	0.46	0.48	0.70	0.61
	s45	0.49	0.56	0.73	0.82

Table 55- Category boundaries for the complete group of respondents, six rating categories

Category Boundaries

CATBOUND

r1	r2	r3	r4	r5
0.000	1.000	2.036	3.350	4.729

Table 56- Scale values for the complete group of respondent, six rating categories

Scale Values

	SCALE
s1	3.061
s2	3.283
s3	3.059
s4	4.000
s5	4.317
s6	2.704
s7	3.048
s8	3.047
s9	4.593
s10	3.107
s11	3.679
s12	3.253
s13	3.501
s14	3.919
s15	2.276
s16	3.048
s17	2.714
s18	3.101
s19	4.165
s20	1.234
s21	4.828
s22	2.732
s23	4.501
s24	4.384
s25	2.792
s26	3.881
s27	2.159
s28	3.731
s29	3.964
s30	3.474
s31	1.284
s32	2.844
s33	4.043
s34	4.010
s35	2.759
s36	4.085
s37	3.350
s38	3.204
s39	2.856
s40	2.081
s41	1.850
s42	4.098
s43	4.269
s44	2.969
s45	2.988

Table 57- Standard deviations of the discriminal process distribution of the attribute for the complete group of respondents, six rating categories

Stimulus STDs

	SCALESTD
s1	1.993
s2	1.666
s3	1.899
s4	1.845
s5	2.051
s6	2.081
s7	2.108
s8	2.083
s9	2.132
s10	2.017
s11	1.778
s12	2.003
s13	2.132
s14	1.956
s15	2.013
s16	1.993
s17	2.064
s18	2.146
s19	1.830
s20	2.425
s21	2.014
s22	1.773
s23	1.736
s24	1.736
s25	1.934
s26	1.998
s27	2.475
s28	2.130
s29	1.799
s30	2.128
s31	2.616
s32	2.152
s33	1.557
s34	2.018
s35	2.428
s36	1.895
s37	1.636
s38	1.799
s39	2.141
s40	2.428
s41	2.499
s42	1.962
s43	1.716
s44	2.077
s45	1.822

Table 58- Reproduced cumulative proportions approbits for the complete group of respondents, six rating categories

Reproduced Cumulative Proportions

APROBITS

	r1	r2	r3	r4	r5
s1	0.062	0.151	0.304	0.558	0.799
s2	0.024	0.085	0.227	0.516	0.807
s3	0.054	0.139	0.295	0.561	0.810
s4	0.015	0.052	0.144	0.362	0.654
s5	0.018	0.053	0.133	0.319	0.580
s6	0.097	0.206	0.374	0.622	0.835
s7	0.074	0.166	0.316	0.557	0.787
s8	0.072	0.163	0.314	0.558	0.790
s9	0.016	0.046	0.115	0.280	0.525
s10	0.062	0.148	0.298	0.548	0.789
s11	0.019	0.066	0.178	0.427	0.723
s12	0.052	0.130	0.272	0.519	0.769
s13	0.050	0.120	0.246	0.472	0.718
s14	0.023	0.068	0.168	0.386	0.661
s15	0.129	0.263	0.453	0.703	0.888
s16	0.063	0.152	0.306	0.560	0.801
s17	0.094	0.203	0.371	0.621	0.836
s18	0.074	0.164	0.310	0.546	0.776
s19	0.011	0.042	0.122	0.328	0.621
s20	0.305	0.462	0.630	0.809	0.925
s21	0.008	0.029	0.083	0.232	0.480
s22	0.062	0.164	0.347	0.636	0.870
s23	0.005	0.022	0.078	0.254	0.552
s24	0.006	0.026	0.088	0.276	0.579
s25	0.074	0.177	0.348	0.614	0.842
s26	0.026	0.075	0.178	0.395	0.664
s27	0.192	0.320	0.480	0.685	0.851
s28	0.040	0.100	0.213	0.429	0.680
s29	0.014	0.050	0.142	0.366	0.665
s30	0.051	0.123	0.250	0.477	0.722
s31	0.312	0.457	0.613	0.785	0.906
s32	0.093	0.196	0.354	0.593	0.809
s33	0.005	0.025	0.099	0.328	0.670
s34	0.023	0.068	0.164	0.372	0.639
s35	0.128	0.234	0.383	0.596	0.791
s36	0.016	0.052	0.140	0.349	0.633
s37	0.020	0.075	0.211	0.500	0.800
s38	0.037	0.110	0.258	0.532	0.802
s39	0.091	0.193	0.351	0.591	0.809
s40	0.196	0.328	0.493	0.699	0.862
s41	0.230	0.367	0.530	0.726	0.875
s42	0.018	0.057	0.147	0.352	0.626
s43	0.006	0.028	0.097	0.296	0.606
s44	0.076	0.172	0.327	0.573	0.802
s45	0.050	0.138	0.301	0.579	0.830

Table 59- Difference between reproduced and original proportions for the complete group of respondents, six rating categories

Difference Between Reproduced And Original Proportions

THURST

	r1	r2	r3	r4	r5
s1	0.002	0.018	0.017	0.025	0.014
s2	0.001	0.007	0.016	0.011	0.009
s3	0.002	0.003	0.024	0.022	0.003
s4	0.008	0.003	0.015	0.023	0.007
s5	0.005	0.011	0.018	0.030	0.031
s6	0.001	0.009	0.011	0.016	0.009
s7	0.009	0.005	0.031	0.012	0.006
s8	0.012	0.011	0.039	0.003	0.015
s9	0.003	0.005	0.005	0.023	0.020
s10	0.002	0.008	0.005	0.025	0.009
s11	0.013	0.007	0.026	0.023	0.002
s12	0.007	0.006	0.019	0.010	0.015
s13	0.009	0.019	0.002	0.009	0.012
s14	0.000	0.004	0.020	0.028	0.009
s15	0.010	0.021	0.003	0.003	0.003
s16	0.001	0.010	0.015	0.001	0.002
s17	0.011	0.020	0.000	0.011	0.009
s18	0.001	0.006	0.007	0.032	0.013
s19	0.002	0.009	0.021	0.007	0.017
s20	0.003	0.007	0.001	0.022	0.008
s21	0.004	0.001	0.004	0.016	0.010
s22	0.003	0.008	0.006	0.003	0.001
s23	0.014	0.019	0.005	0.020	0.012
s24	0.017	0.002	0.004	0.014	0.008
s25	0.001	0.006	0.013	0.010	0.002
s26	0.002	0.008	0.017	0.005	0.010
s27	0.003	0.020	0.012	0.015	0.007
s28	0.001	0.006	0.002	0.039	0.022
s29	0.005	0.001	0.000	0.009	0.005
s30	0.008	0.008	0.034	0.028	0.002
s31	0.004	0.007	0.006	0.010	0.002
s32	0.001	0.006	0.010	0.008	0.002
s33	0.004	0.002	0.007	0.030	0.014
s34	0.001	0.001	0.006	0.023	0.012
s35	0.005	0.004	0.016	0.014	0.011
s36	0.017	0.003	0.002	0.037	0.023
s37	0.003	0.007	0.018	0.004	0.007
s38	0.004	0.005	0.006	0.041	0.017
s39	0.005	0.005	0.007	0.009	0.007
s40	0.003	0.016	0.002	0.025	0.009
s41	0.019	0.000	0.021	0.036	0.022
s42	0.009	0.002	0.005	0.035	0.021
s43	0.007	0.001	0.004	0.016	0.009
s44	0.002	0.002	0.010	0.014	0.003
s45	0.005	0.004	0.012	0.010	0.009

Table 60- Absolute difference between reproduced and original proportions averaged across categories for the complete group of respondents, six rating categories

Absolute Difference Between Reproduced And Original Proportions
Averaged Across Categories
THURST

	r1
s1	0.015
s2	0.009
s3	0.011
s4	0.011
s5	0.019
s6	0.009
s7	0.013
s8	0.016
s9	0.011
s10	0.010
s11	0.014
s12	0.012
s13	0.010
s14	0.012
s15	0.008
s16	0.006
s17	0.010
s18	0.012
s19	0.011
s20	0.008
s21	0.007
s22	0.004
s23	0.014
s24	0.009
s25	0.007
s26	0.008
s27	0.012
s28	0.014
s29	0.004
s30	0.016
s31	0.006
s32	0.005
s33	0.012
s34	0.009
s35	0.010
s36	0.016
s37	0.008
s38	0.015
s39	0.007
s40	0.011
s41	0.019
s42	0.014
s43	0.008
s44	0.006
s45	0.008

APPENDIX F

BOOTSTRAPPED OF PARALLEL ANALYSIS FOR THE COMPLETE GROUP OF RESPONDENTS

Table 61- Observed eigenvalues

Obs	EIGREAL	DIM
1	15.3580	1
2	2.0473	2
3	1.6487	3
4	1.5696	4
5	1.4237	5
6	1.3217	6
7	1.1883	7
8	1.1540	8
9	1.0897	9
10	1.0445	10
11	1.0152	11
12	0.9319	12
13	0.8373	13
14	0.8164	14
15	0.7786	15
16	0.7355	16
17	0.7137	17
18	0.6998	18
19	0.6443	19
20	0.6184	20
21	0.6134	21
22	0.5914	22
23	0.5614	23
24	0.5574	24
25	0.5247	25
26	0.4989	26
27	0.4832	27
28	0.4583	28
29	0.4308	29
30	0.4169	30
31	0.4027	31
32	0.3842	32
33	0.3630	33
34	0.3418	34
35	0.3384	35
36	0.3224	36
37	0.2899	37
38	0.2705	38
39	0.2605	39
40	0.2495	40
41	0.2339	41
42	0.2168	42
43	0.1977	43
44	0.1867	44
45	0.1689	45

Table 62- Generated eigenvalues

Obs	EIGRAND	DIM
1	2.00419	1
2	1.88909	2
3	1.80572	3
4	1.73725	4
5	1.67199	5
6	1.61057	6
7	1.55230	7
8	1.49829	8
9	1.45523	9
10	1.40936	10
11	1.36431	11
12	1.32527	12
13	1.28683	13
14	1.24835	14
15	1.20303	15
16	1.16761	16
17	1.13021	17
18	1.09577	18
19	1.06443	19
20	1.03117	20
21	0.99805	21
22	0.96389	22
23	0.93337	23
24	0.90397	24
25	0.87375	25
26	0.84364	26
27	0.81549	27
28	0.78704	28
29	0.75973	29
30	0.73283	30
31	0.70509	31
32	0.67861	32
33	0.65358	33
34	0.62750	34
35	0.60189	35
36	0.57624	36
37	0.55185	37
38	0.52686	38
39	0.50014	39
40	0.47275	40
41	0.44634	41
42	0.42012	42
43	0.39140	43
44	0.36016	44
45	0.32473	45

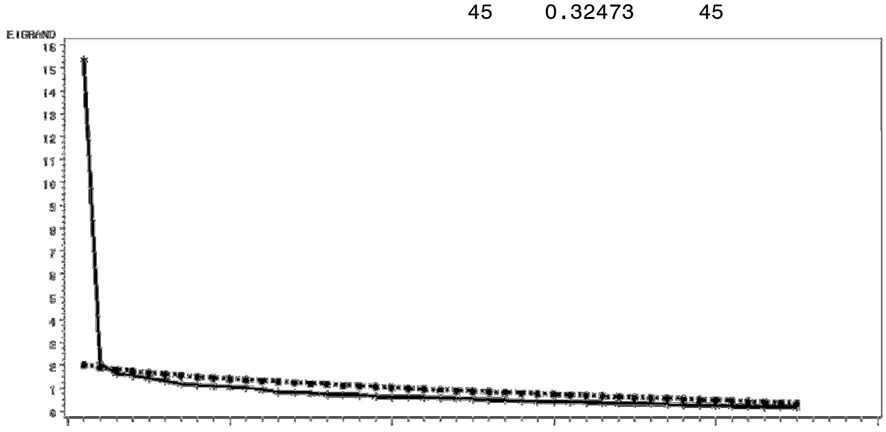

Figure 55- Results of the bootstrapped of parallel analysis

APPENDIX G

FACTOR ANALYIS FOR THE COMPLETE GROUP OF RESPONDENTS

Table 63- Communalities of the factor analysis

Communalities

	Initial	Extraction
v1	.618	.525
v2	.552	.423
v3	.560	.370
v4	.539	.317
v5	.536	.362
v6	.570	.443
v7	.552	.409
v8	.540	.459
v9	.550	.406
v10	.583	.413
v11	.507	.358
v12	.535	.350
v13	.601	.460
v14	.659	.521
v15	.482	.289
v16	.624	.383
v17	.581	.490
v18	.493	.287
v19	.393	.168
v20	.394	.139
v21	.468	.344
v22	.417	.145
v23	.441	.250
v24	.610	.372
v25	.596	.465
v26	.611	.446
v27	.446	.212
v28	.594	.450
v29	.565	.446

Table 63 - Continued

	Initial	Extraction
v30	.512	.400
v31	.422	.318
v32	.504	.308
v33	.521	.399
v34	.548	.342
v35	.541	.452
v36	.574	.433
v37	.586	.471
v38	.466	.307
v39	.428	.253
v40	.398	.177
v41	.535	.433
v42	.499	.244
v43	.518	.355
v44	.428	.267
v45	.553	.298

Extraction Method: Principal Axis Factoring.

Table 64- Eigenvalues and variance explained by the model

Total Variance Explained

Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings[a]
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	15.358	34.129	34.129	14.745	32.766	32.766	13.448
2	2.047	4.549	38.678	1.414	3.143	35.909	12.888
3	1.649	3.664	42.342				
4	1.570	3.488	45.830				
5	1.424	3.164	48.994				
6	1.322	2.937	51.931				
7	1.188	2.641	54.572				
8	1.154	2.564	57.136				
9	1.090	2.422	59.558				
10	1.045	2.321	61.879				
11	1.015	2.256	64.135				

Table 64 - Continued

Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings[a]
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
12	.932	2.071	66.206				
13	.837	1.861	68.067				
14	.816	1.814	69.881				
15	.779	1.730	71.611				
16	.736	1.634	73.245				
17	.714	1.586	74.831				
18	.700	1.555	76.387				
19	.644	1.432	77.818				
20	.618	1.374	79.193				
21	.613	1.363	80.556				
22	.591	1.314	81.870				
23	.561	1.248	83.117				
24	.557	1.239	84.356				
25	.525	1.166	85.522				
26	.499	1.109	86.631				
27	.483	1.074	87.704				
28	.458	1.018	88.723				
29	.431	.957	89.680				
30	.417	.926	90.607				
31	.403	.895	91.501				
32	.384	.854	92.355				
33	.363	.807	93.162				
34	.342	.759	93.921				
35	.338	.752	94.674				
36	.322	.716	95.390				
37	.290	.644	96.034				
38	.271	.601	96.636				
39	.260	.579	97.214				
40	.249	.554	97.769				
41	.234	.520	98.288				
42	.217	.482	98.770				
43	.198	.439	99.210				
44	.187	.415	99.625				
45	.169	.375	100.000				

Extraction Method: Principal Axis Factoring.

a. When factors are correlated, sums of squared loadings cannot be added to obtain a total variance.

Table 65- Factor matrix of the dominant factors

Factor Matrix[a]

	Factor	
	1	2
v1	.718	.094
v2	.641	-.111
v3	.575	-.198
v4	.562	.046
v5	.596	-.080
v6	.665	.024
v7	.639	-.034
v8	.678	-.012
v9	.608	-.190
v10	.623	.158
v11	.572	-.178
v12	.544	.232
v13	.657	-.166
v14	.702	-.170
v15	.515	.152
v16	.617	.046
v17	.626	.313
v18	.486	.226
v19	.410	-.001
v20	.347	.136
v21	.521	-.269
v22	.369	-.094
v23	.465	-.183
v24	.602	-.099
v25	.659	.178
v26	.666	.049
v27	.401	.225
v28	.665	-.087
v29	.629	-.225
v30	.633	-.016
v31	.514	.232
v32	.542	.115
v33	.505	-.380
v34	.583	.050
v35	.618	.264
v36	.640	-.153

Table 65 - Continued

	Factor	
	1	2
v37	.670	-.148
v38	.553	-.043
v39	.468	.184
v40	.364	.212
v41	.538	.380
v42	.492	.052
v43	.520	-.292
v44	.496	.146
v45	.529	-.134

Extraction Method: Principal Axis Factoring.

a. 2 factors extracted. 4 iterations required.

Table 66- Pattern matrix for the dominant factors

Pattern Matrix[a]

	Factor	
	1	2
v1	.281	.487
v2	.531	.147
v3	.619	-.014
v4	.259	.340
v5	.461	.171
v6	.351	.358
v7	.420	.259
v8	.410	.311
v9	.626	.014
v10	.134	.534
v11	.587	.015
v12	-.019	.606
v13	.620	.074
v14	.652	.088
v15	.079	.474
v16	.291	.367
v17	-.088	.765
v18	-.044	.569
v19	.239	.198
v20	.005	.368

Table 66 - Continued

	Factor	
	1	2
v21	.689	-.144
v22	.350	.040
v23	.533	-.044
v24	.492	.145
v25	.126	.581
v26	.315	.396
v27	-.092	.527
v28	.511	.193
v29	.689	-.028
v30	.390	.283
v31	-.036	.591
v32	.148	.433
v33	.839	-.315
v34	.266	.356
v35	-.021	.689
v36	.591	.085
v37	.602	.106
v38	.382	.205
v39	.006	.498
v40	-.095	.489
v41	-.235	.821
v42	.211	.314
v43	.721	-.178
v44	.077	.456
v45	.499	.059

Extraction Method: Principal Axis Factoring.
Rotation Method: Promax with Kaiser Normalization.
a. Rotation converged in 3 iterations.

Table 67- Structure matrix for the dominant factors

Structure Matrix

	Factor	
	1	2
v1	.653	.702
v2	.643	.553
v3	.608	.459
v4	.519	.538
v5	.592	.523
v6	.624	.626
v7	.618	.580
v8	.647	.624
v9	.637	.493
v10	.543	.637
v11	.599	.464
v12	.445	.591
v13	.676	.548
v14	.720	.587
v15	.442	.535
v16	.572	.589
v17	.497	.698
v18	.391	.535
v19	.390	.380
v20	.287	.373
v21	.579	.383
v22	.380	.307
v23	.499	.363
v24	.603	.521
v25	.570	.677
v26	.618	.637
v27	.311	.456
v28	.659	.585
v29	.668	.499
v30	.606	.581
v31	.416	.563
v32	.479	.546
v33	.598	.327
v34	.538	.559
v35	.505	.672
v36	.656	.537

Table 67 - Continued

	Factor	
	1	2
v37	.683	.566
v38	.538	.497
v39	.387	.503
v40	.279	.417
v41	.393	.641
v42	.451	.475
v43	.585	.373
v44	.425	.514
v45	.544	.441

Extraction Method: Principal Axis Factoring.
Rotation Method: Promax with Kaiser Normalization.

Table 68- Correlation between the dominant factors

Factor Correlation Matrix

Factor	1	2
1	1.000	.765
2	.765	1.000

Extraction Method: Principal Axis Factoring.
Rotation Method: Promax with Kaiser Normalization.

APPENDIX H

CLUSTER ANALYSIS FOR THE COMPLETE GROUP OF RESPONDENTS

Table 69- Eigenvalues of the covariance matrix

The CLUSTER Procedure
Average Linkage Cluster Analysis

Eigenvalues of the Covariance Matrix

	Eigenvalue	Difference	Proportion	Cumulative
1	115.359641	89.888856	0.2525	0.2525
2	25.470785	0.821002	0.0558	0.3083
3	24.649784	3.873806	0.0540	0.3622
4	20.775978	3.554390	0.0455	0.4077
5	17.221588	1.039185	0.0377	0.4454
6	16.182403	1.609042	0.0354	0.4808
7	14.573361	0.554016	0.0319	0.5127
8	14.019345	0.605232	0.0307	0.5434
9	13.414112	1.202902	0.0294	0.5728
10	12.211210	1.108992	0.0267	0.5995
11	11.102218	0.674178	0.0243	0.6238
12	10.428040	0.130877	0.0228	0.6466
13	10.297163	0.411963	0.0225	0.6692
14	9.885200	0.651356	0.0216	0.6908
15	9.233844	0.299748	0.0202	0.7110
16	8.934096	0.634863	0.0196	0.7306
17	8.299233	0.601089	0.0182	0.7488
18	7.698143	0.306510	0.0169	0.7656
19	7.391634	0.186439	0.0162	0.7818
20	7.205195	0.452833	0.0158	0.7976
21	6.752362	0.097198	0.0148	0.8123
22	6.655164	0.434420	0.0146	0.8269
23	6.220744	0.560571	0.0136	0.8405
24	5.660173	0.198583	0.0124	0.8529
25	5.461590	0.215734	0.0120	0.8649
26	5.245856	0.226741	0.0115	0.8763
27	5.019115	0.473089	0.0110	0.8873
28	4.546026	0.149317	0.0100	0.8973
29	4.396709	0.169798	0.0096	0.9069
30	4.226912	0.278059	0.0093	0.9162
31	3.948853	0.134201	0.0086	0.9248
32	3.814652	0.156390	0.0084	0.9332
33	3.658261	0.213431	0.0080	0.9412
34	3.444831	0.338330	0.0075	0.9487
35	3.106501	0.138540	0.0068	0.9555
36	2.967961	0.118038	0.0065	0.9620
37	2.849923	0.281817	0.0062	0.9682
38	2.568106	0.210033	0.0056	0.9739
39	2.358073	0.089598	0.0052	0.9790
40	2.268475	0.190237	0.0050	0.9840
41	2.078238	0.252661	0.0045	0.9885
42	1.825577	0.096852	0.0040	0.9925
43	1.728725	0.047153	0.0038	0.9963
44	1.681572	1.681572	0.0037	1.0000

Table 69 - Continued

	Eigenvalue	Difference	Proportion	Cumulative
45	0.000000	0.000000	0.0000	1.0000
46	0.000000	0.000000	0.0000	1.0000
47	0.000000	0.000000	0.0000	1.0000
48	0.000000	0.000000	0.0000	1.0000
49	0.000000	0.000000	0.0000	1.0000
50	0.000000	0.000000	0.0000	1.0000
51	0.000000	0.000000	0.0000	1.0000
52	0.000000	0.000000	0.0000	1.0000
53	0.000000	0.000000	0.0000	1.0000
54	0.000000	0.000000	0.0000	1.0000
55	0.000000	0.000000	0.0000	1.0000
56	0.000000	0.000000	0.0000	1.0000
57	0.000000	0.000000	0.0000	1.0000
58	0.000000	0.000000	0.0000	1.0000
59	0.000000	0.000000	0.0000	1.0000
60	0.000000	0.000000	0.0000	1.0000
61	0.000000	0.000000	0.0000	1.0000
62	0.000000	0.000000	0.0000	1.0000
63	0.000000	0.000000	0.0000	1.0000
64	0.000000	0.000000	0.0000	1.0000
65	0.000000	0.000000	0.0000	1.0000
66	0.000000	0.000000	0.0000	1.0000
67	0.000000	0.000000	0.0000	1.0000
68	0.000000	0.000000	0.0000	1.0000
69	0.000000	0.000000	0.0000	1.0000
70	0.000000	0.000000	0.0000	1.0000
71	0.000000	0.000000	0.0000	1.0000
72	0.000000	0.000000	0.0000	1.0000
73	0.000000	0.000000	0.0000	1.0000
74	0.000000	0.000000	0.0000	1.0000
75	0.000000	0.000000	0.0000	1.0000
76	0.000000	0.000000	0.0000	1.0000
77	0.000000	0.000000	0.0000	1.0000
78	0.000000	0.000000	0.0000	1.0000
79	0.000000	0.000000	0.0000	1.0000
80	0.000000	0.000000	0.0000	1.0000
81	0.000000	0.000000	0.0000	1.0000
82	0.000000	0.000000	0.0000	1.0000
83	0.000000	0.000000	0.0000	1.0000
84	0.000000	0.000000	0.0000	1.0000
85	0.000000	0.000000	0.0000	1.0000
86	0.000000	0.000000	0.0000	1.0000
87	0.000000	0.000000	0.0000	1.0000
88	0.000000	0.000000	0.0000	1.0000
89	0.000000	0.000000	0.0000	1.0000
90	0.000000	0.000000	0.0000	1.0000
91	0.000000	0.000000	0.0000	1.0000
92	0.000000	0.000000	0.0000	1.0000
93	0.000000	0.000000	0.0000	1.0000
94	0.000000	0.000000	0.0000	1.0000
95	0.000000	0.000000	0.0000	1.0000
96	0.000000	0.000000	0.0000	1.0000
97	0.000000	0.000000	0.0000	1.0000
98	0.000000	0.000000	0.0000	1.0000
99	0.000000	0.000000	0.0000	1.0000
100	0.000000	0.000000	0.0000	1.0000
101	0.000000	0.000000	0.0000	1.0000
102	0.000000	0.000000	0.0000	1.0000
103	0.000000	0.000000	0.0000	1.0000
104	0.000000	0.000000	0.0000	1.0000
105	0.000000	0.000000	0.0000	1.0000
106	0.000000	0.000000	0.0000	1.0000
107	0.000000	0.000000	0.0000	1.0000

Table 69 - Continued

	Eigenvalue	Difference	Proportion	Cumulative
108	0.000000	0.000000	0.0000	1.0000
109	0.000000	0.000000	0.0000	1.0000
110	0.000000	0.000000	0.0000	1.0000
111	0.000000	0.000000	0.0000	1.0000
112	0.000000	0.000000	0.0000	1.0000
113	0.000000	0.000000	0.0000	1.0000
114	0.000000	0.000000	0.0000	1.0000
115	0.000000	0.000000	0.0000	1.0000
116	0.000000	0.000000	0.0000	1.0000
117	0.000000	0.000000	0.0000	1.0000
118	0.000000	0.000000	0.0000	1.0000
119	0.000000	0.000000	0.0000	1.0000
120	0.000000	0.000000	0.0000	1.0000
121	0.000000	0.000000	0.0000	1.0000
122	0.000000	0.000000	0.0000	1.0000
123	0.000000	0.000000	0.0000	1.0000
124	0.000000	0.000000	0.0000	1.0000
125	0.000000	0.000000	0.0000	1.0000
126	0.000000	0.000000	0.0000	1.0000
127	0.000000	0.000000	0.0000	1.0000
128	0.000000	0.000000	0.0000	1.0000
129	0.000000	0.000000	0.0000	1.0000
130	0.000000	0.000000	0.0000	1.0000
131	-0.000000	0.000000	-0.0000	1.0000
132	-0.000000	0.000000	-0.0000	1.0000
133	-0.000000	0.000000	-0.0000	1.0000
134	-0.000000	0.000000	-0.0000	1.0000
135	-0.000000	0.000000	-0.0000	1.0000
136	-0.000000	0.000000	-0.0000	1.0000
137	-0.000000	0.000000	-0.0000	1.0000
138	-0.000000	0.000000	-0.0000	1.0000
139	-0.000000	0.000000	-0.0000	1.0000
140	-0.000000	0.000000	-0.0000	1.0000
141	-0.000000	0.000000	-0.0000	1.0000
142	-0.000000	0.000000	-0.0000	1.0000
143	-0.000000	0.000000	-0.0000	1.0000
144	-0.000000	0.000000	-0.0000	1.0000
145	-0.000000	0.000000	-0.0000	1.0000
146	-0.000000	0.000000	-0.0000	1.0000
147	-0.000000	0.000000	-0.0000	1.0000
148	-0.000000	0.000000	-0.0000	1.0000
149	-0.000000	0.000000	-0.0000	1.0000
150	-0.000000	0.000000	-0.0000	1.0000
151	-0.000000	0.000000	-0.0000	1.0000
152	-0.000000	0.000000	-0.0000	1.0000
153	-0.000000	0.000000	-0.0000	1.0000
154	-0.000000	0.000000	-0.0000	1.0000
155	-0.000000	0.000000	-0.0000	1.0000
156	-0.000000	0.000000	-0.0000	1.0000
157	-0.000000	0.000000	-0.0000	1.0000
158	-0.000000	0.000000	-0.0000	1.0000
159	-0.000000	0.000000	-0.0000	1.0000
160	-0.000000	0.000000	-0.0000	1.0000
161	-0.000000	0.000000	-0.0000	1.0000
162	-0.000000	0.000000	-0.0000	1.0000
163	-0.000000	0.000000	-0.0000	1.0000
164	-0.000000	0.000000	-0.0000	1.0000
165	-0.000000	0.000000	-0.0000	1.0000
166	-0.000000	0.000000	-0.0000	1.0000
167	-0.000000	0.000000	-0.0000	1.0000
168	-0.000000	0.000000	-0.0000	1.0000
169	-0.000000	0.000000	-0.0000	1.0000
170	-0.000000	0.000000	-0.0000	1.0000

Table 69 - Continued

	Eigenvalue	Difference	Proportion	Cumulative
171	-0.000000	0.000000	-0.0000	1.0000
172	-0.000000	0.000000	-0.0000	1.0000
173	-0.000000	0.000000	-0.0000	1.0000
174	-0.000000	0.000000	-0.0000	1.0000
175	-0.000000	0.000000	-0.0000	1.0000
176	-0.000000	0.000000	-0.0000	1.0000
177	-0.000000	0.000000	-0.0000	1.0000
178	-0.000000	0.000000	-0.0000	1.0000
179	-0.000000	0.000000	-0.0000	1.0000
180	-0.000000	0.000000	-0.0000	1.0000
181	-0.000000	0.000000	-0.0000	1.0000
182	-0.000000	0.000000	-0.0000	1.0000
183	-0.000000	0.000000	-0.0000	1.0000
184	-0.000000	0.000000	-0.0000	1.0000
185	-0.000000	0.000000	-0.0000	1.0000
186	-0.000000	0.000000	-0.0000	1.0000
187	-0.000000	0.000000	-0.0000	1.0000
188	-0.000000	0.000000	-0.0000	1.0000
189	-0.000000	0.000000	-0.0000	1.0000
190	-0.000000	0.000000	-0.0000	1.0000
191	-0.000000	0.000000	-0.0000	1.0000
192	-0.000000	0.000000	-0.0000	1.0000
193	-0.000000	0.000000	-0.0000	1.0000
194	-0.000000	0.000000	-0.0000	1.0000
195	-0.000000	0.000000	-0.0000	1.0000
196	-0.000000	0.000000	-0.0000	1.0000
197	-0.000000	0.000000	-0.0000	1.0000
198	-0.000000	0.000000	-0.0000	1.0000
199	-0.000000	0.000000	-0.0000	1.0000
200	-0.000000	0.000000	-0.0000	1.0000
201	-0.000000	0.000000	-0.0000	1.0000
202	-0.000000	0.000000	-0.0000	1.0000
203	-0.000000	0.000000	-0.0000	1.0000
204	-0.000000	0.000000	-0.0000	1.000
205	-0.000000	0.000000	-0.0000	1.0000
206	-0.000000	0.000000	-0.0000	1.0000
207	-0.000000	0.000000	-0.0000	1.0000
208	-0.000000	0.000000	-0.0000	1.0000
209	-0.000000	0.000000	-0.0000	1.0000
210	-0.000000	0.000000	-0.0000	1.0000
211	-0.000000	0.000000	-0.0000	1.0000
212	-0.000000	0.000000	-0.0000	1.0000
213	-0.000000	0.000000	-0.0000	1.0000
214	-0.000000	0.000000	-0.0000	1.0000
215	-0.000000	0.000000	-0.0000	1.0000
216	-0.000000	0.000000	-0.0000	1.0000
217	-0.000000	0.000000	-0.0000	1.0000
218	-0.000000		-0.0000	1.0000

Table 70- Cluster history table

Root-Mean-Square Total-Sample Standard Deviation = 1.447613
Mean Distance Between Observations = 29.43407

Cluster History

NCL	-Clusters Joined--		FREQ	STD	RMS SPRSQ	RSQ	ERSQ	CCC	PSF	PST2	Dist e
44	Q28_OPEN	Q31_INFO	2	0.8391	0.0076	.992	.	.	3.0	.	0.5953
43	Q21_EARL	Q40_ADEQ	2	0.8687	0.0082	.984	.	.	3.0	.	0.6162
42	CL43	Q36_ACCO	3	0.8848	0.0088	.975	.	.	2.9	1.1	0.6333
41	Q11_MUTU	Q12_TRUS	2	0.9011	0.0088	.967	.	.	2.9	.	0.6392
40	Q16_EARL	Q42_EFFI	2	0.9011	0.0088	.958	.	.	2.9	.	0.6392
39	CL44	Q50_TIME	3	0.8883	0.0095	.948	.	.	2.9	1.2	0.6466
38	Q26_OWNE	Q30_ORGA	2	0.9373	0.0095	.939	.	.	2.9	.	0.6649
37	CL40	CL39	5	0.9272	0.0114	.927	.	.	2.8	1.3	0.6734
36	CL41	Q43_UNDE	3	0.9482	0.0107	.917	.	.	2.8	1.2	0.688
35	CL37	CL42	8	0.9485	0.0140	.903	.	.	2.7	1.6	0.6908
34	Q33_KNOW	Q49_PERS	2	0.9815	0.0104	.892	.	.	2.8	.	0.6963
33	CL36	Q35_COMM	4	0.9768	0.0115	.881	.	.	2.8	1.2	0.7125
32	CL35	CL38	10	0.9724	0.0145	.866	.	.	2.7	1.5	0.7191
31	Q9_INT_C	CL33	5	1.0009	0.0124	.854	.	.	2.7	1.2	0.7344
30	Q18_TEAM	CL34	3	1.0182	0.0120	.842	.	.	2.8	1.2	0.7347
29	Q15_INNO	Q32_CONT	2	1.0372	0.0117	.830	.	.	2.8	.	0.7358
28	Q29_PROJ	Q52_TEAM	2	1.0482	0.0119	.818	.	.	2.8	.	0.7436
27	CL31	CL32	15	1.0175	0.0214	.797	.	.	2.7	2.1	0.7505
26	CL27	Q41_TOP_	16	1.0234	0.0132	.784	.	.	2.8	1.2	0.7544
25	Q20_INTE	Q37_CONT	2	1.0826	0.0127	.771	.	.	2.8	.	0.768
24	CL26	CL30	19	1.0429	0.0195	.751	.	.	2.8	1.7	0.773
23	Q10_PERF	Q14_TRAI	2	1.1057	0.0133	.738	.	.	2.8	.	0.7844
22	Q8_ADEQU	Q44_SUB_	2	1.1077	0.0133	.725	.	.	2.9	.	0.7858
21	Q19_COLL	Q23_APPR	2	1.1524	0.0144	.710	.	.	2.9	.	0.8175
20	CL24	CL25	21	1.0676	0.0222	.688	.	.	2.9	1.9	0.8292
19	CL23	CL29	4	1.1397	0.0173	.671	.	.	2.9	1.4	0.8312
18	Q17_TEAM	CL21	3	1.1718	0.0154	.656	.	.	3.0	1.1	0.838
17	CL22	CL20	23	1.0920	0.0240	.631	.	.	3.0	1.9	0.8538
16	CL19	CL18	7	1.2005	0.0217	.610	.	.	3.0	1.5	0.8765
15	CL17	CL16	30	1.1599	0.0448	.565	.	.	2.8	3.3	0.8878
14	CL15	CL28	32	1.1796	0.0328	.532	.	.	2.7	2.3	0.9316
13	Q13_BENE	Q22_REWA	2	1.3367	0.0194	.513	.	.	2.8	.	0.9482
12	Q39_DELI	Q45_FACI	2	1.3427	0.0196	.493	.	.	2.9	.	0.9525
11	Q24_SHAR	Q25_OWNE	2	1.3452	0.0196	.474	.	.	3.1	.	0.9543
10	CL13	Q42_LONG	3	1.3636	0.0210	.453	.	.	3.2	1.1	0.9767
9	CL11	CL12	4	1.3779	0.0226	.430	.528	-5.4	3.4	1.2	0.9889
8	CL14	Q51_COMP	33	1.1939	0.0268	.403	.496	-4.9	3.6	1.8	0.9895
7	CL8	CL9	37	1.2450	0.0487	.354	.462	-5.3	3.5	3.1	1.0092
6	CL7	CL10	40	1.2808	0.0484	.306	.425	-5.6	3.4	2.8	1.0428
5	Q34_ELIM	Q48_OPEN	2	1.7040	0.0315	.275	.385	-4.9	3.8	.	1.2088
4	Q27_ONE_	Q38_FACI	2	1.7380	0.0328	.242	.338	-4.1	4.4	.	1.2329
3	CL6	CL5	42	1.3362	0.0686	.173	.283	-4.3	4.4	3.8	1.2616
2	CL3	Q46_LESS	43	1.3688	0.0596	.114	.207	-3.5	5.5	3.1	1.3581
1	CL2	CL4	45	1.4476	0.1138	.000	.000	0.00	.	5.5	1.4845

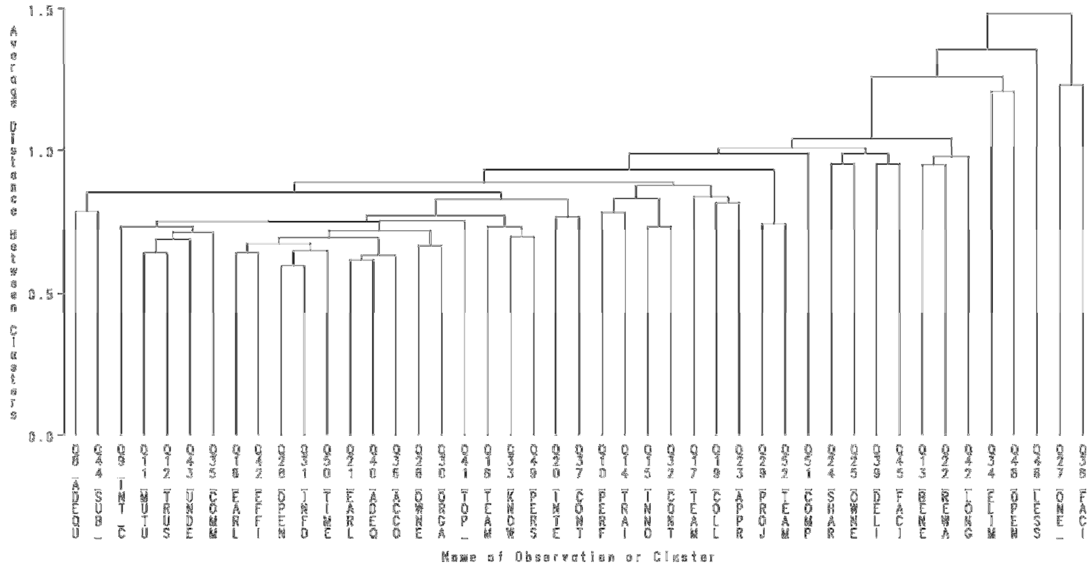

Figure 56- Dendrogram of the cluster analysis of the attributes across respondents

APPENDIX I

THURSTONE'S SUCCESSIVE INTERVAL PROCEDURE FOR OWNERS AND FACILITY MANAGERS

Table 71- Observed frequencies for owners and facility managers

Obs	stimulus	_1	_2	_3	_4	_5	_6
1	1	0	2	8	10	6	8
2	2	0	0	6	10	11	7
3	3	0	2	6	7	8	11
4	4	0	0	2	7	8	17
5	5	1	1	3	7	10	12
6	6	2	4	7	6	9	6
7	7	4	2	2	10	7	9
8	8	1	4	4	8	8	9
9	9	0	1	4	4	8	17
10	10	0	4	4	10	10	6
11	11	3	1	3	8	13	6
12	12	3	3	3	10	10	5
13	13	2	1	2	9	11	9
14	14	1	2	3	8	10	10
15	15	5	6	3	8	7	5
16	16	4	0	7	10	8	5
17	17	3	4	6	9	7	5
18	18	0	5	2	4	11	12
19	19	0	0	0	7	11	16
20	20	4	4	8	10	5	3
21	21	0	2	2	3	12	15
22	22	2	1	4	13	9	5
23	23	0	1	1	5	12	15
24	24	1	0	3	3	13	14
25	25	2	2	4	11	8	7
26	26	2	2	0	7	12	11
27	27	5	6	6	6	7	4
28	28	1	2	2	7	13	9
29	29	1	3	1	4	9	16
30	30	2	2	1	11	8	10
31	31	8	5	5	5	4	7
32	32	3	3	3	13	10	2
33	33	1	1	3	4	15	10
34	34	0	1	1	9	10	13
35	35	3	2	6	5	10	8
36	36	0	0	6	3	14	11
37	37	0	2	4	10	12	6
38	38	0	0	4	13	10	7
39	39	3	1	3	6	10	11
40	40	8	4	3	10	6	3
41	41	8	2	7	6	5	6
42	42	2	0	4	7	10	11
43	43	0	0	4	5	14	11
44	44	1	2	5	7	13	6
45	45	1	3	3	10	12	5

Table 72- Matrix of proportions for owners and facility managers

Matrix Of Proportions

PROP

	r1	r2	r3	r4	r5	r6
s1	0.00	0.06	0.24	0.29	0.18	0.24
s2	0.00	0.00	0.18	0.29	0.32	0.21
s3	0.00	0.06	0.18	0.21	0.24	0.32
s4	0.00	0.00	0.06	0.21	0.24	0.50
s5	0.03	0.03	0.09	0.21	0.29	0.35
s6	0.06	0.12	0.21	0.18	0.26	0.18
s7	0.12	0.06	0.06	0.29	0.21	0.26
s8	0.03	0.12	0.12	0.24	0.24	0.26
s9	0.00	0.03	0.12	0.12	0.24	0.50
s10	0.00	0.12	0.12	0.29	0.29	0.18
s11	0.09	0.03	0.09	0.24	0.38	0.18
s12	0.09	0.09	0.09	0.29	0.29	0.15
s13	0.06	0.03	0.06	0.26	0.32	0.26
s14	0.03	0.06	0.09	0.24	0.29	0.29
s15	0.15	0.18	0.09	0.24	0.21	0.15
s16	0.12	0.00	0.21	0.29	0.24	0.15
s17	0.09	0.12	0.18	0.26	0.21	0.15
s18	0.00	0.15	0.06	0.12	0.32	0.35
s19	0.00	0.00	0.00	0.21	0.32	0.47
s20	0.12	0.12	0.24	0.29	0.15	0.09
s21	0.00	0.06	0.06	0.09	0.35	0.44
s22	0.06	0.03	0.12	0.38	0.26	0.15
s23	0.00	0.03	0.03	0.15	0.35	0.44
s24	0.03	0.00	0.09	0.09	0.38	0.41
s25	0.06	0.06	0.12	0.32	0.24	0.21
s26	0.06	0.06	0.00	0.21	0.35	0.32
s27	0.15	0.18	0.18	0.18	0.21	0.12
s28	0.03	0.06	0.06	0.21	0.38	0.26
s29	0.03	0.09	0.03	0.12	0.26	0.47
s30	0.06	0.06	0.03	0.32	0.24	0.29
s31	0.24	0.15	0.15	0.15	0.12	0.21
s32	0.09	0.09	0.09	0.38	0.29	0.06
s33	0.03	0.03	0.09	0.12	0.44	0.29
s34	0.00	0.03	0.03	0.26	0.29	0.38
s35	0.09	0.06	0.18	0.15	0.29	0.24
s36	0.00	0.00	0.18	0.09	0.41	0.32
s37	0.00	0.06	0.12	0.29	0.35	0.18
s38	0.00	0.00	0.12	0.38	0.29	0.21
s39	0.09	0.03	0.09	0.18	0.29	0.32
s40	0.24	0.12	0.09	0.29	0.18	0.09
s41	0.24	0.06	0.21	0.18	0.15	0.18
s42	0.06	0.00	0.12	0.21	0.29	0.32
s43	0.00	0.00	0.12	0.15	0.41	0.32
s44	0.03	0.06	0.15	0.21	0.38	0.18
s45	0.03	0.09	0.09	0.29	0.35	0.15

Table 73- Matrix of cumulative proportions for owners and facility managers

Matrix Of Cummulative Proportions

CUMPROP

	r1	r2	r3	r4	r5	r6
s1	0.000	0.059	0.294	0.588	0.765	1.000
s2	0.000	0.000	0.176	0.471	0.794	1.000
s3	0.000	0.059	0.235	0.441	0.676	1.000
s4	0.000	0.000	0.059	0.265	0.500	1.000
s5	0.029	0.059	0.147	0.353	0.647	1.000
s6	0.059	0.176	0.382	0.559	0.824	1.000
s7	0.118	0.176	0.235	0.529	0.735	1.000
s8	0.029	0.147	0.265	0.500	0.735	1.000
s9	0.000	0.029	0.147	0.265	0.500	1.000
s10	0.000	0.118	0.235	0.529	0.824	1.000
s11	0.088	0.118	0.206	0.441	0.824	1.000
s12	0.088	0.176	0.265	0.559	0.853	1.000
s13	0.059	0.088	0.147	0.412	0.735	1.000
s14	0.029	0.088	0.176	0.412	0.706	1.000
s15	0.147	0.324	0.412	0.647	0.853	1.000
s16	0.118	0.118	0.324	0.618	0.853	1.000
s17	0.088	0.206	0.382	0.647	0.853	1.000
s18	0.000	0.147	0.206	0.324	0.647	1.000
s19	0.000	0.000	0.000	0.206	0.529	1.000
s20	0.118	0.235	0.471	0.765	0.912	1.000
s21	0.000	0.059	0.118	0.206	0.559	1.000
s22	0.059	0.088	0.206	0.588	0.853	1.000
s23	0.000	0.029	0.059	0.206	0.559	1.000
s24	0.029	0.029	0.118	0.206	0.588	1.000
s25	0.059	0.118	0.235	0.559	0.794	1.000
s26	0.059	0.118	0.118	0.324	0.676	1.000
s27	0.147	0.324	0.500	0.676	0.882	1.000
s28	0.029	0.088	0.147	0.353	0.735	1.000
s29	0.029	0.118	0.147	0.265	0.529	1.000
s30	0.059	0.118	0.147	0.471	0.706	1.000
s31	0.235	0.382	0.529	0.676	0.794	1.000
s32	0.088	0.176	0.265	0.647	0.941	1.000
s33	0.029	0.059	0.147	0.265	0.706	1.000
s34	0.000	0.029	0.059	0.324	0.618	1.000
s35	0.088	0.147	0.324	0.471	0.765	1.000
s36	0.000	0.000	0.176	0.265	0.676	1.000
s37	0.000	0.059	0.176	0.471	0.824	1.000
s38	0.000	0.000	0.118	0.500	0.794	1.000
s39	0.088	0.118	0.206	0.382	0.676	1.000
s40	0.235	0.353	0.441	0.735	0.912	1.000
s41	0.235	0.294	0.500	0.676	0.824	1.000
s42	0.059	0.059	0.176	0.382	0.676	1.000
s43	0.000	0.000	0.118	0.265	0.676	1.000
s44	0.029	0.088	0.235	0.441	0.824	1.000
s45	0.029	0.118	0.206	0.500	0.853	1.000

Table 74- Matrix of probits for owners and facility managers

Matrix Of Probits (Z-scores)

PROBITS

	r1	r2	r3	r4	r5
s1	.	-1.56	-.541	0.223	0.722
s2	.	.	-.929	-.074	0.821
s3	.	-1.56	-.722	-.148	0.458
s4	.	.	-1.56	-.629	-.000
s5	.	-1.56	-1.05	-.377	0.377
s6	-1.56	-.929	-.299	0.148	0.929
s7	-1.19	-.929	-.722	0.074	0.629
s8	.	-1.05	-.629	-.000	0.629
s9	.	.	-1.05	-.629	-.000
s10	.	-1.19	-.722	0.074	0.929
s11	-1.35	-1.19	-.821	-.148	0.929
s12	-1.35	-.929	-.629	0.148	1.049
s13	-1.56	-1.35	-1.05	-.223	0.629
s14	.	-1.35	-.929	-.223	0.541
s15	-1.05	-.458	-.223	0.377	1.049
s16	-1.19	-1.19	-.458	0.299	1.049
s17	-1.35	-.821	-.299	0.377	1.049
s18	.	-1.05	-.821	-.458	0.377
s19	.	.	.	-.821	0.074
s20	-1.19	-.722	-.074	0.722	1.352
s21	.	-1.56	-1.19	-.821	0.148
s22	-1.56	-1.35	-.821	0.223	1.049
s23	.	.	-1.56	-.821	0.148
s24	.	.	-1.19	-.821	0.223
s25	-1.56	-1.19	-.722	0.148	0.821
s26	-1.56	-1.19	-1.19	-.458	0.458
s27	-1.05	-.458	-.000	0.458	1.187
s28	.	-1.35	-1.05	-.377	0.629
s29	.	-1.19	-1.05	-.629	0.074
s30	-1.56	-1.19	-1.05	-.074	0.541
s31	-.722	-.299	0.074	0.458	0.821
s32	-1.35	-.929	-.629	0.377	1.565
s33	.	-1.56	-1.05	-.629	0.541
s34	.	.	-1.56	-.458	0.299
s35	-1.35	-1.05	-.458	-.074	0.722
s36	.	.	-.929	-.629	0.458
a37	.	-1.56	-.929	-.074	0.929
s38	.	.	-1.19	-.000	0.821
s39	-1.35	-1.19	-.821	-.299	0.458
s40	-.722	-.377	-.148	0.629	1.352
s41	-.722	-.541	-.000	0.458	0.929
s42	-1.56	-1.56	-.929	-.299	0.458
s43	.	.	-1.19	-.629	0.458
s44	.	-1.35	-.722	-.148	0.929
s45	.	-1.19	-.821	-.000	1.049

Table 75-Matrix of aprobits for owners and facility managers

APROBITS

Matrix Of Probit Differences

	r1	r2	r3	r4
s1	.	1.02	0.76	0.50
s2	.	.	0.86	0.89
s3	.	0.84	0.57	0.61
s4	.	.	0.94	0.63
s5	.	0.52	0.67	0.75
s6	0.64	0.63	0.45	0.78
s7	0.26	0.21	0.80	0.56
s8	.	0.42	0.63	0.63
s9	.	.	0.42	0.63
s10	.	0.47	0.80	0.86
s11	0.16	0.37	0.67	1.08
s12	0.42	0.30	0.78	0.90
s13	0.21	0.30	0.83	0.85
s14	.	0.42	0.71	0.76
s15	0.59	0.23	0.60	0.67
s16	0.00	0.73	0.76	0.75
s17	0.53	0.52	0.68	0.67
s18	.	0.23	0.36	0.84
s19	.	.	.	0.89
s20	0.47	0.65	0.80	0.63
s21	.	0.38	0.37	0.97
s22	0.21	0.53	1.04	0.83
s23	.	.	0.74	0.97
s24	.	.	0.37	1.04
s25	0.38	0.47	0.87	0.67
s26	0.38	0.00	0.73	0.92
s27	0.59	0.46	0.46	0.73
s28	.	0.30	0.67	1.01
s29	.	0.14	0.42	0.70
s30	0.38	0.14	0.98	0.62
s31	0.42	0.37	0.38	0.36
s32	0.42	0.30	1.01	1.19
s33	.	0.52	0.42	1.17
s34	.	.	1.11	0.76
s35	0.30	0.59	0.38	0.80
s36	.	.	0.30	1.09
s37	.	0.64	0.86	1.00
s38	.	.	1.19	0.82
s39	0.16	0.37	0.52	0.76
s40	0.34	0.23	0.78	0.72
s41	0.18	0.54	0.46	0.47
s42	0.00	0.64	0.63	0.76
s43	.	.	0.56	1.09
s44	.	0.63	0.57	1.08
s45	.	0.37	0.82	1.05

Table 76- Category boundaries for owners and facility managers

Category Boundaries

CATBOUND

r1	r2	r3	r4	r5
0.000	1.000	1.905	3.012	4.211

Table 77-Scale values for owners and facility managers

Scale Values	
	SCALE
s1	2.947
s2	3.123
s3	3.338
s4	4.124
s5	3.611
s6	2.617
s7	2.979
s8	3.029
s9	4.269
s10	2.871
s11	2.974
s12	2.628
s13	3.357
s14	3.354
s15	2.151
s16	2.543
s17	2.389
s18	3.645
s19	4.112
s20	1.997
s21	4.187
s22	2.777
s23	4.046
s24	4.010
s25	2.878
s26	3.719
s27	1.972
s28	3.395
s29	4.290
s30	3.320
s31	1.845
s32	2.305
s33	3.600
s34	3.755
s35	2.924
s36	3.648
s37	3.059
s38	3.183
s39	3.494
s40	1.731
s41	1.966
s42	3.549
s43	3.675
s44	2.998
s45	2.871

Table 78- Standard deviations of the discriminal process distributions of attributes for owners and facility managers

Stimulus STDs

	SCALESTD
s1	1.428
s2	1.318
s3	1.632
s4	1.478
s5	1.651
s6	1.724
s7	2.232
s8	1.893
s9	2.193
s10	1.498
s11	1.839
s12	1.760
s13	1.871
s14	1.676
s15	2.065
s16	1.743
s17	1.738
s18	2.283
s19	1.340
s20	1.601
s21	1.933
s22	1.523
s23	1.344
s24	1.626
s25	1.702
s26	2.150
s27	1.936
s28	1.607
s29	2.519
s30	1.942
s31	2.726
s32	1.445
s33	1.581
s34	1.241
s35	2.032
s36	1.651
s37	1.285
s38	1.152
s39	2.294
s40	2.007
s41	2.427
s42	1.953
s43	1.397
s44	1.443
s45	1.414

Table 79- Reduced cumulative proportions aprobits for owners and facility managers

Reproduced Cumulative Propotions

APROBITS

	r1	r2	r3	r4	r5
s1	0.020	0.086	0.233	0.518	0.812
s2	0.009	0.054	0.178	0.467	0.795
s3	0.020	0.076	0.190	0.421	0.704
s4	0.003	0.017	0.067	0.226	0.524
s5	0.014	0.057	0.151	0.358	0.642
s6	0.064	0.174	0.340	0.591	0.822
s7	0.091	0.188	0.315	0.506	0.710
s8	0.055	0.142	0.276	0.497	0.734
s9	0.026	0.068	0.141	0.283	0.489
s10	0.028	0.106	0.259	0.538	0.814
s11	0.053	0.142	0.281	0.508	0.749
s12	0.068	0.177	0.341	0.586	0.816
s13	0.036	0.104	0.219	0.427	0.676
s14	0.023	0.080	0.194	0.419	0.695
s15	0.149	0.289	0.453	0.662	0.841
s16	0.072	0.188	0.357	0.606	0.831
s17	0.085	0.212	0.390	0.640	0.853
s18	0.055	0.123	0.223	0.391	0.598
s19	0.001	0.010	0.050	0.206	0.529
s20	0.106	0.267	0.477	0.737	0.917
s21	0.015	0.050	0.119	0.272	0.505
s22	0.034	0.122	0.284	0.561	0.827
s23	0.001	0.012	0.056	0.221	0.549
s24	0.007	0.032	0.098	0.270	0.549
s25	0.045	0.135	0.284	0.531	0.783
s26	0.042	0.103	0.199	0.371	0.590
s27	0.154	0.308	0.486	0.704	0.876
s28	0.017	0.068	0.177	0.406	0.694
s29	0.044	0.096	0.172	0.306	0.487
s30	0.044	0.116	0.233	0.437	0.677
s31	0.249	0.378	0.509	0.666	0.807
s32	0.055	0.183	0.391	0.688	0.906
s33	0.011	0.050	0.142	0.355	0.650
s34	0.001	0.013	0.068	0.275	0.643
s35	0.075	0.172	0.308	0.517	0.737
s36	0.014	0.054	0.146	0.350	0.633
s37	0.009	0.055	0.185	0.486	0.815
s38	0.003	0.029	0.134	0.441	0.814
s39	0.064	0.138	0.244	0.417	0.623
s40	0.194	0.358	0.535	0.738	0.892
s41	0.209	0.345	0.490	0.667	0.823
s42	0.035	0.096	0.200	0.392	0.633
s43	0.004	0.028	0.103	0.318	0.649
s44	0.019	0.083	0.224	0.504	0.800
s45	0.021	0.093	0.247	0.540	0.828

Table 80- Difference between reproduced and original proportions for owners and facility managers

Difference Between Reproduced And Original Proportions

THURST

	r1	r2	r3	r4	r5
s1	0.020	0.028	0.061	0.070	0.047
s2	0.009	0.054	0.001	0.004	0.001
s3	0.020	0.017	0.045	0.020	0.027
s4	0.003	0.017	0.008	0.039	0.024
s5	0.015	0.002	0.004	0.006	0.005
s6	0.006	0.002	0.043	0.032	0.001
s7	0.027	0.011	0.080	0.023	0.026
s8	0.025	0.005	0.012	0.003	0.002
s9	0.026	0.039	0.007	0.019	0.011
s10	0.028	0.012	0.024	0.008	0.009
s11	0.035	0.024	0.075	0.067	0.074
s12	0.021	0.001	0.076	0.028	0.037
s13	0.022	0.016	0.072	0.015	0.059
s14	0.007	0.008	0.017	0.007	0.010
s15	0.002	0.035	0.041	0.015	0.012
s16	0.045	0.070	0.034	0.011	0.022
s17	0.004	0.006	0.008	0.007	0.000
s18	0.055	0.024	0.017	0.067	0.049
s19	0.001	0.010	0.050	0.000	0.000
s20	0.011	0.032	0.007	0.028	0.005
s21	0.015	0.009	0.001	0.066	0.054
s22	0.025	0.034	0.078	0.027	0.026
s23	0.001	0.018	0.003	0.015	0.010
s24	0.023	0.003	0.020	0.064	0.039
s25	0.013	0.017	0.049	0.027	0.011
s26	0.017	0.015	0.082	0.048	0.086
s27	0.007	0.016	0.014	0.028	0.006
s28	0.012	0.020	0.030	0.053	0.041
s29	0.015	0.022	0.025	0.041	0.042
s30	0.015	0.002	0.086	0.034	0.029
s31	0.014	0.004	0.021	0.011	0.013
s32	0.033	0.007	0.126	0.041	0.035
s33	0.018	0.009	0.005	0.090	0.055
s34	0.001	0.016	0.009	0.049	0.026
s35	0.013	0.025	0.015	0.047	0.028
s36	0.014	0.054	0.031	0.085	0.043
s37	0.009	0.004	0.008	0.015	0.009
s38	0.003	0.029	0.016	0.059	0.020
s39	0.024	0.021	0.038	0.034	0.054
s40	0.041	0.005	0.093	0.003	0.020
s41	0.026	0.051	0.010	0.010	0.001
s42	0.024	0.037	0.024	0.009	0.044
s43	0.004	0.028	0.015	0.053	0.027
s44	0.011	0.005	0.011	0.063	0.024
s45	0.008	0.025	0.041	0.040	0.025

Table 81- Absolute difference between reproduced and original proportions averaged across categories for owners and facility managers

Absolute Difference Between Reproduced And Original Proportions
Averaged Across Categories
THURST

	r1
s1	0.045
s2	0.014
s3	0.026
s4	0.018
s5	0.006
s6	0.017
s7	0.033
s8	0.009
s9	0.020
s10	0.016
s11	0.055
s12	0.032
s13	0.037
s14	0.010
s15	0.021
s16	0.037
s17	0.005
s18	0.043
s19	0.012
s20	0.016
s21	0.029
s22	0.038
s23	0.009
s24	0.030
s25	0.024
s26	0.049
s27	0.014
s28	0.031
s29	0.029
s30	0.033
s31	0.012
s32	0.048
s33	0.036
s34	0.020
s35	0.026
s36	0.045
s37	0.009
s38	0.025
s39	0.034
s40	0.033
s41	0.020
s42	0.028
s43	0.025
s44	0.023
s45	0.028

APPENDIX J

THURSTONE'S SUCCESSIVE INTERVAL PROCEDURE FOR ARCHITECTS

Table 82- Observed frequencies for architects

Obs	stimulus	_1	_2	_3	_4	_5	_6
1	1	3	4	10	10	12	11
2	2	3	0	7	10	17	13
3	3	1	3	5	12	17	12
4	4	0	1	2	12	16	19
5	5	1	1	1	7	16	24
6	6	4	5	8	14	8	11
7	7	2	3	5	14	14	12
8	8	3	1	10	7	15	14
9	9	1	0	2	7	15	25
10	10	2	5	5	8	12	18
11	11	0	2	5	18	11	14
12	12	5	1	7	7	13	17
13	13	2	3	7	8	15	15
14	14	0	2	8	11	11	18
15	15	4	6	11	12	10	7
16	16	0	3	9	11	14	13
17	17	3	2	5	10	13	17
18	18	2	3	8	11	13	13
19	19	0	5	2	13	12	18
20	20	18	9	5	10	4	4
21	21	0	1	0	6	14	29
22	22	5	6	13	12	12	2
23	23	0	3	2	10	15	20
24	24	0	0	1	7	18	24
25	25	3	5	7	12	15	8
26	26	1	0	5	13	10	21
27	27	8	6	5	13	10	8
28	28	1	2	6	9	13	19
29	29	0	0	6	12	13	19
30	30	1	1	8	12	10	18
31	31	16	7	6	7	9	5
32	32	1	6	10	12	9	12
33	33	0	0	3	14	14	19
34	34	1	2	5	9	10	23
35	35	7	4	6	9	12	12
36	36	0	0	1	10	17	22
37	37	0	0	6	19	16	9
38	38	4	2	9	19	8	8
39	39	5	2	11	15	11	6
40	40	9	8	4	9	13	7
41	41	7	8	6	14	4	11
42	42	1	1	3	8	17	20
43	43	0	3	3	9	14	21
44	44	5	3	7	12	11	12
45	45	3	2	6	18	15	6

Table 83- Matrix of proportions for architects

Matrix Of Proportions

PROP

	r1	r2	r3	r4	r5	r6
s1	0.06	0.08	0.20	0.20	0.24	0.22
s2	0.06	0.00	0.14	0.20	0.34	0.26
s3	0.02	0.06	0.10	0.24	0.34	0.24
s4	0.00	0.02	0.04	0.24	0.32	0.38
s5	0.02	0.02	0.02	0.14	0.32	0.48
s6	0.08	0.10	0.16	0.28	0.16	0.22
s7	0.04	0.06	0.10	0.28	0.28	0.24
s8	0.06	0.02	0.20	0.14	0.30	0.28
s9	0.02	0.00	0.04	0.14	0.30	0.50
s10	0.04	0.10	0.10	0.16	0.24	0.36
s11	0.00	0.04	0.10	0.36	0.22	0.28
s12	0.10	0.02	0.14	0.14	0.26	0.34
s13	0.04	0.06	0.14	0.16	0.30	0.30
s14	0.00	0.04	0.16	0.22	0.22	0.36
s15	0.08	0.12	0.22	0.24	0.20	0.14
s16	0.00	0.06	0.18	0.22	0.28	0.26
s17	0.06	0.04	0.10	0.20	0.26	0.34
s18	0.04	0.06	0.16	0.22	0.26	0.26
s19	0.00	0.10	0.04	0.26	0.24	0.36
s20	0.36	0.18	0.10	0.20	0.08	0.08
s21	0.00	0.02	0.00	0.12	0.28	0.58
s22	0.10	0.12	0.26	0.24	0.24	0.04
s23	0.00	0.06	0.04	0.20	0.30	0.40
s24	0.00	0.00	0.02	0.14	0.36	0.48
s25	0.06	0.10	0.14	0.24	0.30	0.16
s26	0.02	0.00	0.10	0.26	0.20	0.42
s27	0.16	0.12	0.10	0.26	0.20	0.16
s28	0.02	0.04	0.12	0.18	0.26	0.38
s29	0.00	0.00	0.12	0.24	0.26	0.38
s30	0.02	0.02	0.16	0.24	0.20	0.36
s31	0.32	0.14	0.12	0.14	0.18	0.10
s32	0.02	0.12	0.20	0.24	0.18	0.24
s33	0.00	0.00	0.06	0.28	0.28	0.38
s34	0.02	0.04	0.10	0.18	0.20	0.46
s35	0.14	0.08	0.12	0.18	0.24	0.24
s36	0.00	0.00	0.02	0.20	0.34	0.44
s37	0.00	0.00	0.12	0.38	0.32	0.18
s38	0.08	0.04	0.18	0.38	0.16	0.16
s39	0.10	0.04	0.22	0.30	0.22	0.12
s40	0.18	0.16	0.08	0.18	0.26	0.14
s41	0.14	0.16	0.12	0.28	0.08	0.22
s42	0.02	0.02	0.06	0.16	0.34	0.40
s43	0.00	0.06	0.06	0.18	0.28	0.42
s44	0.10	0.06	0.14	0.24	0.22	0.24
s45	0.06	0.04	0.12	0.36	0.30	0.12

Table 84- Matrix of cumulative proportions for architects

Matrix Of Cummulative Proportions

CUMPROP

	r1	r2	r3	r4	r5	r6
s1	0.060	0.140	0.340	0.540	0.780	1.000
s2	0.060	0.060	0.200	0.400	0.740	1.000
s3	0.020	0.080	0.180	0.420	0.760	1.000
s4	0.000	0.020	0.060	0.300	0.620	1.000
s5	0.020	0.040	0.060	0.200	0.520	1.000
s6	0.080	0.180	0.340	0.620	0.780	1.000
s7	0.040	0.100	0.200	0.480	0.760	1.000
s8	0.060	0.080	0.280	0.420	0.720	1.000
s9	0.020	0.020	0.060	0.200	0.500	1.000
s10	0.040	0.140	0.240	0.400	0.640	1.000
s11	0.000	0.040	0.140	0.500	0.720	1.000
s12	0.100	0.120	0.260	0.400	0.660	1.000
s13	0.040	0.100	0.240	0.400	0.700	1.000
s14	0.000	0.040	0.200	0.420	0.640	1.000
s15	0.080	0.200	0.420	0.660	0.860	1.000
s16	0.000	0.060	0.240	0.460	0.740	1.000
s17	0.060	0.100	0.200	0.400	0.660	1.000
s18	0.040	0.100	0.260	0.480	0.740	1.000
s19	0.000	0.100	0.140	0.400	0.640	1.000
s20	0.360	0.540	0.640	0.840	0.920	1.000
s21	0.000	0.020	0.020	0.140	0.420	1.000
s22	0.100	0.220	0.480	0.720	0.960	1.000
s23	0.000	0.060	0.100	0.300	0.600	1.000
s24	0.000	0.000	0.020	0.160	0.520	1.000
s25	0.060	0.160	0.300	0.540	0.840	1.000
s26	0.020	0.020	0.120	0.380	0.580	1.000
s27	0.160	0.280	0.380	0.640	0.840	1.000
s28	0.020	0.060	0.180	0.360	0.620	1.000
s29	0.000	0.000	0.120	0.360	0.620	1.000
s30	0.020	0.040	0.200	0.440	0.640	1.000
s31	0.320	0.460	0.580	0.720	0.900	1.000
s32	0.020	0.140	0.340	0.580	0.760	1.000
s33	0.000	0.000	0.060	0.340	0.620	1.000
s34	0.020	0.060	0.160	0.340	0.540	1.000
s35	0.140	0.220	0.340	0.520	0.760	1.000
s36	0.000	0.000	0.020	0.220	0.560	1.000
s37	0.000	0.000	0.120	0.500	0.820	1.000
s38	0.080	0.120	0.300	0.680	0.840	1.000
s39	0.100	0.140	0.360	0.660	0.880	1.000
s40	0.180	0.340	0.420	0.600	0.860	1.000
s41	0.140	0.300	0.420	0.700	0.780	1.000
s42	0.020	0.040	0.100	0.260	0.600	1.000
s43	0.000	0.060	0.120	0.300	0.580	1.000
s44	0.100	0.160	0.300	0.540	0.760	1.000
s45	0.060	0.100	0.220	0.580	0.880	1.000

Table 85- Matrix of probits for architects

Matrix Of Probits (Z-scores)

PROBITS

	r1	r2	r3	r4	r5
s1	-1.55	-1.08	-.412	0.100	0.772
s2	-1.55	-1.55	-.842	-.253	0.643
s3	.	-1.41	-.915	-.202	0.706
s4	.	.	-1.55	-.524	0.305
s5	.	.	-1.55	-.842	0.050
s6	-1.41	-.915	-.412	0.305	0.772
s7	.	-1.28	-.842	-.050	0.706
s8	-1.55	-1.41	-.583	-.202	0.583
s9	.	.	-1.55	-.842	-.000
s10	.	-1.08	-.706	-.253	0.358
s11	.	.	-1.08	-.000	0.583
s12	-1.28	-1.17	-.643	-.253	0.412
s13	.	-1.28	-.706	-.253	0.524
s14	.	.	-.842	-.202	0.358
s15	-1.41	-.842	-.202	0.412	1.080
s16	.	-1.55	-.706	-.100	0.643
s17	-1.55	-1.28	-.842	-.253	0.412
s18	.	-1.28	-.643	-.050	0.643
s19	.	-1.28	-1.08	-.253	0.358
s20	-.358	0.100	0.358	0.994	1.405
s21	.	.	.	-1.08	-.202
s22	-1.28	-.772	-.050	0.583	.
s23	.	-1.55	-1.28	-.524	0.253
s24	.	.	.	-.994	0.050
s25	-1.55	-.994	-.524	0.100	0.994
s26	.	.	-1.17	-.305	0.202
s27	-.994	-.583	-.305	0.358	0.994
s28	.	-1.55	-.915	-.358	0.305
s29	.	.	-1.17	-.358	0.305
s30	.	.	-.842	-.151	0.358
s31	-.468	-.100	0.202	0.583	1.282
s32	.	-1.08	-.412	0.202	0.706
s33	.	.	-1.55	-.412	0.305
s34	.	-1.55	-.994	-.412	0.100
s35	-1.08	-.772	-.412	0.050	0.706
s36	.	.	.	-.772	0.151
s37	.	.	-1.17	-.000	0.915
s38	-1.41	-1.17	-.524	0.468	0.994
s39	-1.28	-1.08	-.358	0.412	1.175
s40	-.915	-.412	-.202	0.253	1.080
s41	-1.08	-.524	-.202	0.524	0.772
s42	.	.	-1.28	-.643	0.253
s43	.	-1.55	-1.17	-.524	0.202
s44	-1.28	-.994	-.524	0.100	0.706
s45	-1.55	-1.28	-.772	0.202	1.175

Table 86- Matrix of aprobits for architects

APROBITS

Matrix Of Probit Differences		r1	r2	r3	r4
	s1	0.47	0.67	0.51	0.67
	s2	0.00	0.71	0.59	0.90
	s3	.	0.49	0.71	0.91
	s4	.	.	1.03	0.83
	s5	.	.	0.71	0.89
	s6	0.49	0.50	0.72	0.47
	s7	.	0.44	0.79	0.76
	s8	0.15	0.82	0.38	0.78
	s9	.	.	0.71	0.84
	s10	.	0.37	0.45	0.61
	s11	.	.	1.08	0.58
	s12	0.11	0.53	0.39	0.67
	s13	.	0.58	0.45	0.78
	s14	.	.	0.64	0.56
	s15	0.56	0.64	0.61	0.67
	s16	.	0.85	0.61	0.74
	s17	0.27	0.44	0.59	0.67
	s18	.	0.64	0.59	0.69
	s19	.	0.20	0.83	0.61
	s20	0.46	0.26	0.64	0.41
	s21	.	.	.	0.88
	s22	0.51	0.72	0.63	.
	s23	.	0.27	0.76	0.78
	s24	.	.	.	1.04
	s25	0.56	0.47	0.62	0.89
	s26	.	.	0.87	0.51
	s27	0.41	0.28	0.66	0.64
	s28	.	0.64	0.56	0.66
	s29	.	.	0.82	0.66
	s30	.	.	0.69	0.51
	s31	0.37	0.30	0.38	0.70
	s32	.	0.67	0.61	0.50
	s33	.	.	1.14	0.72
	s34	.	0.56	0.58	0.51
	s35	0.31	0.36	0.46	0.66
	s36	.	.	.	0.92
	s37	.	.	1.17	0.92
	s38	0.23	0.65	0.99	0.53
	s39	0.20	0.72	0.77	0.76
	s40	0.50	0.21	0.46	0.83
	s41	0.56	0.32	0.73	0.25
	s42	.	.	0.64	0.90
	s43	.	0.38	0.65	0.73
	s44	0.29	0.47	0.62	0.61
	s45	0.27	0.51	0.97	0.97

Table 87-Category boundaries for architects

Category Boundaries

CATBOUND

r1	r2	r3	r4	r5
0.000	1.000	2.096	3.293	4.406

Table 88- Scale values for architects

Scale Values

	SCALE
s1	2.987
s2	3.539
s3	3.434
s4	3.999
s5	4.393
s6	2.818
s7	3.318
s8	3.438
s9	4.454
s10	3.705
s11	3.495
s12	3.669
s13	3.534
s14	3.705
s15	2.500
s16	3.381
s17	3.729
s18	3.296
s19	3.817
s20	0.905
s21	4.662
s22	2.258
s23	4.131
s24	4.353
s25	2.868
s26	3.978
s27	2.398
s28	3.873
s29	3.903
s30	3.671
s31	1.364
s32	2.978
s33	3.951
s34	4.171
s35	2.920
s36	4.224
s37	3.361
s38	2.723
s39	2.550
s40	2.252
s41	2.397
s42	4.106
s43	4.169
s44	3.030
s45	2.869

Table 89- Standard deviations for the discriminal process distribution of the attributes for architects

Stimulus STDs	SCALESTD
s1	1.904
s2	1.938
s3	1.619
s4	1.241
s5	1.442
s6	1.990
s7	1.688
s8	2.023
s9	1.488
s10	2.394
s11	1.385
s12	2.567
s13	1.947
s14	1.924
s15	1.785
s16	1.587
s17	2.230
s18	1.794
s19	1.981
s20	2.509
s21	1.267
s22	1.738
s23	1.844
s24	1.066
s25	1.791
s26	1.673
s27	2.251
s28	1.861
s29	1.559
s30	1.923
s31	2.652
s32	1.912
s33	1.239
s34	2.058
s35	2.521
s36	1.206
s37	1.104
s38	1.716
s39	1.727
s40	2.382
s41	2.337
s42	1.509
s43	1.927
s44	2.183
s45	1.591

Table 90- Reproduced cumulative proportions aprobits for architects

Reproduced Cumulative Propotions

APROBITS

	r1	r2	r3	r4	r5
s1	0.058	0.148	0.320	0.564	0.772
s2	0.034	0.095	0.228	0.449	0.673
s3	0.017	0.066	0.204	0.465	0.726
s4	0.001	0.008	0.063	0.285	0.629
s5	0.001	0.009	0.056	0.223	0.504
s6	0.078	0.181	0.358	0.594	0.788
s7	0.025	0.085	0.235	0.494	0.740
s8	0.045	0.114	0.253	0.471	0.684
s9	0.001	0.010	0.057	0.218	0.487
s10	0.061	0.129	0.251	0.432	0.615
s11	0.006	0.036	0.156	0.442	0.745
s12	0.076	0.149	0.270	0.442	0.613
s13	0.035	0.097	0.230	0.451	0.673
s14	0.027	0.080	0.202	0.415	0.642
s15	0.081	0.200	0.410	0.672	0.857
s16	0.017	0.067	0.209	0.478	0.741
s17	0.047	0.111	0.232	0.423	0.619
s18	0.033	0.100	0.252	0.499	0.732
s19	0.027	0.078	0.193	0.396	0.617
s20	0.359	0.515	0.683	0.829	0.919
s21	0.000	0.002	0.021	0.140	0.420
s22	0.097	0.235	0.463	0.724	0.892
s23	0.013	0.045	0.135	0.325	0.559
s24	0.000	0.001	0.017	0.160	0.520
s25	0.055	0.149	0.333	0.594	0.805
s26	0.009	0.038	0.130	0.341	0.601
s27	0.143	0.267	0.447	0.655	0.814
s28	0.019	0.061	0.170	0.378	0.613
s29	0.006	0.031	0.123	0.348	0.626
s30	0.028	0.082	0.206	0.422	0.649
s31	0.303	0.445	0.609	0.766	0.874
s32	0.060	0.150	0.322	0.565	0.773
s33	0.001	0.009	0.067	0.298	0.643
s34	0.021	0.062	0.157	0.335	0.546
s35	0.123	0.223	0.372	0.559	0.722
s36	0.000	0.004	0.039	0.220	0.560
s37	0.001	0.016	0.126	0.476	0.828
s38	0.056	0.158	0.357	0.630	0.837
s39	0.070	0.185	0.396	0.666	0.859
s40	0.172	0.300	0.474	0.669	0.817
s41	0.152	0.275	0.449	0.649	0.805
s42	0.003	0.020	0.091	0.295	0.579
s43	0.015	0.050	0.141	0.325	0.549
s44	0.083	0.176	0.334	0.548	0.736
s45	0.036	0.120	0.313	0.605	0.833

Table 91- Difference between reproduced and original proportions for architects

Difference Between Reproduced And Original Proportions

THURST

	r1	r2	r3	r4	r5
s1	0.002	0.008	0.020	0.024	0.008
s2	0.026	0.035	0.028	0.049	0.067
s3	0.003	0.014	0.024	0.045	0.034
s4	0.001	0.012	0.003	0.015	0.009
s5	0.019	0.031	0.004	0.023	0.016
s6	0.002	0.001	0.018	0.026	0.008
s7	0.015	0.015	0.035	0.014	0.020
s8	0.015	0.034	0.027	0.051	0.036
s9	0.019	0.010	0.003	0.018	0.013
s10	0.021	0.011	0.011	0.032	0.025
s11	0.006	0.004	0.016	0.058	0.025
s12	0.024	0.029	0.010	0.042	0.047
s13	0.005	0.003	0.010	0.051	0.027
s14	0.027	0.040	0.002	0.005	0.002
s15	0.001	0.000	0.010	0.012	0.003
s16	0.017	0.007	0.031	0.018	0.001
s17	0.013	0.011	0.032	0.023	0.041
s18	0.007	0.000	0.008	0.019	0.008
s19	0.027	0.022	0.053	0.004	0.023
s20	0.001	0.025	0.043	0.011	0.001
s21	0.000	0.018	0.001	0.000	0.000
s22	0.003	0.015	0.017	0.004	0.068
s23	0.013	0.015	0.035	0.025	0.041
s24	0.000	0.001	0.003	0.000	0.000
s25	0.005	0.011	0.033	0.054	0.035
s26	0.011	0.018	0.010	0.039	0.021
s27	0.017	0.013	0.067	0.015	0.026
s28	0.001	0.001	0.010	0.018	0.007
s29	0.006	0.031	0.003	0.012	0.006
s30	0.008	0.042	0.006	0.018	0.009
s31	0.017	0.015	0.029	0.046	0.026
s32	0.040	0.010	0.018	0.015	0.013
s33	0.001	0.009	0.007	0.042	0.023
s34	0.001	0.002	0.003	0.005	0.006
s35	0.017	0.003	0.032	0.039	0.038
s36	0.000	0.004	0.019	0.000	0.000
s37	0.001	0.016	0.006	0.024	0.008
s38	0.024	0.038	0.057	0.050	0.003
s39	0.030	0.045	0.036	0.006	0.021
s40	0.008	0.040	0.054	0.069	0.043
s41	0.012	0.025	0.029	0.051	0.025
s42	0.017	0.020	0.009	0.035	0.021
s43	0.015	0.010	0.021	0.025	0.031
s44	0.017	0.016	0.034	0.008	0.024
s45	0.024	0.020	0.093	0.025	0.047

Table 92- Absolute difference between reproduced and original proportions averaged across categories for architects

Absolute Difference Between Reproduced And Original Proportions
Averaged Across Categories
THURST

	r1
s1	0.012
s2	0.041
s3	0.024
s4	0.008
s5	0.019
s6	0.011
s7	0.020
s8	0.033
s9	0.012
s10	0.020
s11	0.022
s12	0.030
s13	0.019
s14	0.015
s15	0.005
s16	0.015
s17	0.024
s18	0.009
s19	0.026
s20	0.016
s21	0.004
s22	0.021
s23	0.026
s24	0.001
s25	0.028
s26	0.020
s27	0.027
s28	0.008
s29	0.012
s30	0.017
s31	0.026
s32	0.019
s33	0.016
s34	0.003
s35	0.026
s36	0.005
s37	0.011
s38	0.034
s39	0.028
s40	0.043
s41	0.028
s42	0.020
s43	0.020
s44	0.020
s45	0.042

APPENDIX K

THURSTONE'S SUCCESSIVE INTERVAL PROCEDURE FOR ENGINEERS OR SPECIALTY CONSULTANTS

Table 93- Observed frequencies for engineers or specialty consultants

Obs	stimulus	_1	_2	_3	_4	_5	_6
1	1	7	6	10	21	15	15
2	2	1	5	16	24	17	11
3	3	5	6	10	27	17	9
4	4	4	4	6	21	18	21
5	5	3	6	3	14	22	26
6	6	10	3	17	20	13	11
7	7	9	7	8	20	17	13
8	8	6	15	12	15	8	18
9	9	3	4	4	13	22	28
10	10	6	7	17	15	18	11
11	11	3	5	5	18	20	23
12	12	2	7	6	25	22	12
13	13	6	1	17	16	18	16
14	14	2	2	10	12	24	24
15	15	10	10	17	21	9	7
16	16	6	5	10	23	18	12
17	17	11	5	18	20	12	8
18	18	6	8	13	14	20	13
19	19	2	3	5	11	29	24
20	20	29	12	10	13	2	8
21	21	1	1	9	11	18	34
22	22	4	6	12	21	20	11
23	23	3	1	3	8	25	34
24	24	2	1	7	14	21	29
25	25	7	10	13	20	12	12
26	26	1	5	9	21	20	18
27	27	17	10	8	15	10	14
28	28	4	7	7	13	24	19
29	29	3	2	5	18	28	18
30	30	6	5	7	27	15	14
31	31	24	13	9	12	12	4
32	32	13	10	8	21	13	9
33	33	1	2	3	21	23	24
34	34	1	4	7	14	26	22
35	35	10	12	9	16	17	10
36	36	4	2	8	14	23	23
37	37	3	4	16	12	21	18
38	38	3	9	10	23	16	13
39	39	8	10	9	19	16	12
40	40	13	16	15	14	11	5
41	41	20	14	15	13	5	7
42	42	2	2	5	11	26	28
43	43	2	0	3	14	28	27
44	44	5	5	13	24	15	12
45	45	5	9	15	18	15	12

Table 94- Matrix of proportions for engineers or specialty consultants

Matrix Of Proportions

PROP

	r1	r2	r3	r4	r5	r6
s1	0.09	0.08	0.14	0.28	0.20	0.20
s2	0.01	0.07	0.22	0.32	0.23	0.15
s3	0.07	0.08	0.14	0.36	0.23	0.12
s4	0.05	0.05	0.08	0.28	0.24	0.28
s5	0.04	0.08	0.04	0.19	0.30	0.35
s6	0.14	0.04	0.23	0.27	0.18	0.15
s7	0.12	0.09	0.11	0.27	0.23	0.18
s8	0.08	0.20	0.16	0.20	0.11	0.24
s9	0.04	0.05	0.05	0.18	0.30	0.38
s10	0.08	0.09	0.23	0.20	0.24	0.15
s11	0.04	0.07	0.07	0.24	0.27	0.31
s12	0.03	0.09	0.08	0.34	0.30	0.16
s13	0.08	0.01	0.23	0.22	0.24	0.22
s14	0.03	0.03	0.14	0.16	0.32	0.32
s15	0.14	0.14	0.23	0.28	0.12	0.09
s16	0.08	0.07	0.14	0.31	0.24	0.16
s17	0.15	0.07	0.24	0.27	0.16	0.11
s18	0.08	0.11	0.18	0.19	0.27	0.18
s19	0.03	0.04	0.07	0.15	0.39	0.32
s20	0.39	0.16	0.14	0.18	0.03	0.11
s21	0.01	0.01	0.12	0.15	0.24	0.46
s22	0.05	0.08	0.16	0.28	0.27	0.15
s23	0.04	0.01	0.04	0.11	0.34	0.46
s24	0.03	0.01	0.09	0.19	0.28	0.39
s25	0.09	0.14	0.18	0.27	0.16	0.16
s26	0.01	0.07	0.12	0.28	0.27	0.24
s27	0.23	0.14	0.11	0.20	0.14	0.19
s28	0.05	0.09	0.09	0.18	0.32	0.26
s29	0.04	0.03	0.07	0.24	0.38	0.24
s30	0.08	0.07	0.09	0.36	0.20	0.19
s31	0.32	0.18	0.12	0.16	0.16	0.05
s32	0.18	0.14	0.11	0.28	0.18	0.12
s33	0.01	0.03	0.04	0.28	0.31	0.32
s34	0.01	0.05	0.09	0.19	0.35	0.30
s35	0.14	0.16	0.12	0.22	0.23	0.14
s36	0.05	0.03	0.11	0.19	0.31	0.31
s37	0.04	0.05	0.22	0.16	0.28	0.24
s38	0.04	0.12	0.14	0.31	0.22	0.18
s39	0.11	0.14	0.12	0.26	0.22	0.16
s40	0.18	0.22	0.20	0.19	0.15	0.07
s41	0.27	0.19	0.20	0.18	0.07	0.09
s42	0.03	0.03	0.07	0.15	0.35	0.38
s43	0.03	0.00	0.04	0.19	0.38	0.36
s44	0.07	0.07	0.18	0.32	0.20	0.16
s45	0.07	0.12	0.20	0.24	0.20	0.16

Table 95- Matrix of cumulative proportions for engineers or specialty consultants

Matrix Of Cummulative Proportions
CUMPROP

	r1	r2	r3	r4	r5	r6
s1	0.095	0.176	0.311	0.595	0.797	1.000
s2	0.014	0.081	0.297	0.622	0.851	1.000
s3	0.068	0.149	0.284	0.649	0.878	1.000
s4	0.054	0.108	0.189	0.473	0.716	1.000
s5	0.041	0.122	0.162	0.351	0.649	1.000
s6	0.135	0.176	0.405	0.676	0.851	1.000
s7	0.122	0.216	0.324	0.595	0.824	1.000
s8	0.081	0.284	0.446	0.649	0.757	1.000
s9	0.041	0.095	0.149	0.324	0.622	1.000
s10	0.081	0.176	0.405	0.608	0.851	1.000
s11	0.041	0.108	0.176	0.419	0.689	1.000
s12	0.027	0.122	0.203	0.541	0.838	1.000
s13	0.081	0.095	0.324	0.541	0.784	1.000
s14	0.027	0.054	0.189	0.351	0.676	1.000
s15	0.135	0.270	0.500	0.784	0.905	1.000
s16	0.081	0.149	0.284	0.595	0.838	1.000
s17	0.149	0.216	0.459	0.730	0.892	1.000
s18	0.081	0.189	0.365	0.554	0.824	1.000
s19	0.027	0.068	0.135	0.284	0.676	1.000
s20	0.392	0.554	0.689	0.865	0.892	1.000
s21	0.014	0.027	0.149	0.297	0.541	1.000
s22	0.054	0.135	0.297	0.581	0.851	1.000
s23	0.041	0.054	0.095	0.203	0.541	1.000
s24	0.027	0.041	0.135	0.324	0.608	1.000
s25	0.095	0.230	0.405	0.676	0.838	1.000
s26	0.014	0.081	0.203	0.486	0.757	1.000
s27	0.230	0.365	0.473	0.676	0.811	1.000
s28	0.054	0.149	0.243	0.419	0.743	1.000
s29	0.041	0.068	0.135	0.378	0.757	1.000
s30	0.081	0.149	0.243	0.608	0.811	1.000
s31	0.324	0.500	0.622	0.784	0.946	1.000
s32	0.176	0.311	0.419	0.703	0.878	1.000
s33	0.014	0.041	0.081	0.365	0.676	1.000
s34	0.014	0.068	0.162	0.351	0.703	1.000
s35	0.135	0.297	0.419	0.635	0.865	1.000
s36	0.054	0.081	0.189	0.378	0.689	1.000
s37	0.041	0.095	0.311	0.473	0.757	1.000
s38	0.041	0.162	0.297	0.608	0.824	1.000
s39	0.108	0.243	0.365	0.622	0.838	1.000
s40	0.176	0.392	0.595	0.784	0.932	1.000
s41	0.270	0.459	0.662	0.838	0.905	1.000
s42	0.027	0.054	0.122	0.270	0.622	1.000
s43	0.027	0.027	0.068	0.257	0.635	1.000
s44	0.068	0.135	0.311	0.635	0.838	1.000
s45	0.068	0.189	0.392	0.635	0.838	1.000

Table 96- Matrix of probits for engineers or specialty consultants

Matrix Of Probits (Z-scores)

PROBITS

	r1	r2	r3	r4	r5
s1	-1.31	-.932	-.494	0.239	0.832
s2	.	-1.40	-.532	0.310	1.042
s3	-1.49	-1.04	-.572	0.382	1.167
s4	-1.61	-1.24	-.881	-.068	0.572
s5	.	-1.17	-.986	-.382	0.382
s6	-1.10	-.932	-.239	0.456	1.042
s7	-1.17	-.785	-.456	0.239	0.932
s8	-1.40	-.572	-.136	0.382	0.696
s9	.	-1.31	-1.04	-.456	0.310
s10	-1.40	-.932	-.239	0.274	1.042
s11	.	-1.24	-.932	-.205	0.494
s12	.	-1.17	-.832	0.102	0.986
s13	-1.40	-1.31	-.456	0.102	0.785
s14	.	-1.61	-.881	-.382	0.456
s15	-1.10	-.612	-.000	0.785	1.313
s16	-1.40	-1.04	-.572	0.239	0.986
s17	-1.04	-.785	-.102	0.612	1.237
s18	-1.40	-.881	-.345	0.136	0.932
s19	.	-1.49	-1.10	-.572	0.456
s20	-.274	0.136	0.494	1.102	1.237
s21	.	.	-1.04	-.532	0.102
s22	-1.61	-1.10	-.532	0.205	1.042
s23	.	-1.61	-1.31	-.832	0.102
s24	.	.	-1.10	-.456	0.274
s25	-1.31	-.740	-.239	0.456	0.986
s26	.	-1.40	-.832	-.034	0.696
s27	-.740	-.345	-.068	0.456	0.881
s28	-1.61	-1.04	-.696	-.205	0.653
s29	.	-1.49	-1.10	-.310	0.696
s30	-1.40	-1.04	-.696	0.274	0.881
s31	-.456	-.000	0.310	0.785	1.607
s32	-.932	-.494	-.205	0.532	1.167
s33	.	.	-1.40	-.345	0.456
s34	.	-1.49	-.986	-.382	0.532
s35	-1.10	-.532	-.205	0.345	1.102
s36	-1.61	-1.40	-.881	-.310	0.494
s37	.	-1.31	-.494	-.068	0.696
s38	.	-.986	-.532	0.274	0.932
s39	-1.24	-.696	-.345	0.310	0.986
s40	-.932	-.274	0.239	0.785	1.494
s41	-.612	-.102	0.418	0.986	1.313
s42	.	-1.61	-1.17	-.612	0.310
s43	.	.	-1.49	-.653	0.345
s44	-1.49	-1.10	-.494	0.345	0.986
s45	-1.49	-.881	-.274	0.345	0.986

Table 97- Aprobits for engineers or specialty consultants

APROBITS		r1	r2	r3	r4
Matrix Of Probit Differences	s1	0.38	0.44	0.73	0.59
	s2	.	0.87	0.84	0.73
	s3	0.45	0.47	0.95	0.79
	s4	0.37	0.36	0.81	0.64
	s5	.	0.18	0.60	0.76
	s6	0.17	0.69	0.70	0.59
	s7	0.38	0.33	0.70	0.69
	s8	0.83	0.44	0.52	0.31
	s9	.	0.27	0.59	0.77
	s10	0.47	0.69	0.51	0.77
	s11	.	0.30	0.73	0.70
	s12	.	0.33	0.93	0.88
	s13	0.08	0.86	0.56	0.68
	s14	.	0.73	0.50	0.84
	s15	0.49	0.61	0.79	0.53
	s16	0.36	0.47	0.81	0.75
	s17	0.26	0.68	0.71	0.62
	s18	0.52	0.54	0.48	0.80
	s19	.	0.39	0.53	1.03
	s20	0.41	0.36	0.61	0.13
	s21	.	.	0.51	0.63
	s22	0.50	0.57	0.74	0.84
	s23	.	0.29	0.48	0.93
	s24	.	.	0.65	0.73
	s25	0.57	0.50	0.70	0.53
	s26	.	0.57	0.80	0.73
	s27	0.39	0.28	0.52	0.43
	s28	0.56	0.35	0.49	0.86
	s29	.	0.39	0.79	1.01
	s30	0.36	0.35	0.97	0.61
	s31	0.46	0.31	0.48	0.82
	s32	0.44	0.29	0.74	0.63
	s33	.	.	1.05	0.80
	s34	.	0.51	0.60	0.91
	s35	0.57	0.33	0.55	0.76
	s36	0.21	0.52	0.57	0.80
	s37	.	0.82	0.43	0.76
	s38	.	0.45	0.81	0.66
	s39	0.54	0.35	0.66	0.68
	s40	0.66	0.51	0.55	0.71
	s41	0.51	0.52	0.57	0.33
	s42	.	0.44	0.55	0.92
	s43	.	.	0.84	1.00
	s44	0.39	0.61	0.84	0.64
	s45	0.61	0.61	0.62	0.64

Table 98- Category boundaries for engineers or specialty consultants

Category Boundaries

CATBOUND

r1	r2	r3	r4	r5
0.000	1.000	1.939	3.093	4.260

Table 99- Scale values for engineers or specialty consultants

Scale Values

	SCALE
s1	2.704
s2	2.767
s3	2.547
s4	3.289
s5	3.683
s6	2.348
s7	2.558
s8	2.486
s9	3.817
s10	2.495
s11	3.436
s12	2.908
s13	2.895
s14	3.562
s15	1.928
s16	2.682
s17	2.087
s18	2.640
s19	3.727
s20	0.619
s21	4.093
s22	2.698
s23	4.337
s24	3.818
s25	2.370
s26	3.178
s27	1.962
s28	3.201
s29	3.388
s30	2.770
s31	1.093
s32	2.031
s33	3.635
s34	3.523
s35	2.215
s36	3.535
s37	3.075
s38	2.703
s39	2.440
s40	1.587
s41	1.193
s42	3.900
s43	3.855
s44	2.640
s45	2.512

Table 100- Standard deviations of the discriminal process distribution of the attributes for engineers or specialty consultants

Stimulus STDs

	SCALESTD
s1	1.937
s2	1.345
s3	1.565
s4	1.910
s5	2.062
s6	1.866
s7	2.021
s8	2.081
s9	1.990
s10	1.744
s11	1.837
s12	1.469
s13	1.834
s14	1.639
s15	1.705
s16	1.746
s17	1.779
s18	1.868
s19	1.702
s20	2.672
s21	2.028
s22	1.603
s23	1.934
s24	1.685
s25	1.834
s26	1.543
s27	2.621
s28	1.973
s29	1.475
s30	1.796
s31	2.150
s32	2.021
s33	1.252
s34	1.631
s35	2.001
s36	1.995
s37	1.704
s38	1.663
s39	1.942
s40	1.797
s41	2.159
s42	1.726
s43	1.261
s44	1.653
s45	1.719

Table 101- Reproduced cumulative proportions aprobits for engineers or specialty consultants

Reproduced Cumulative Propotions

APROBITS

	r1	r2	r3	r4	r5
s1	0.081	0.189	0.346	0.579	0.789
s2	0.020	0.094	0.269	0.596	0.866
s3	0.052	0.162	0.349	0.636	0.863
s4	0.043	0.115	0.240	0.459	0.694
s5	0.037	0.097	0.199	0.387	0.610
s6	0.104	0.235	0.413	0.655	0.847
s7	0.103	0.220	0.380	0.604	0.800
s8	0.116	0.238	0.396	0.615	0.803
s9	0.028	0.078	0.173	0.358	0.588
s10	0.076	0.196	0.375	0.634	0.844
s11	0.031	0.092	0.208	0.426	0.673
s12	0.024	0.097	0.255	0.550	0.821
s13	0.057	0.151	0.301	0.543	0.772
s14	0.015	0.059	0.161	0.387	0.665
s15	0.129	0.293	0.503	0.753	0.914
s16	0.062	0.168	0.335	0.593	0.817
s17	0.120	0.271	0.467	0.714	0.889
s18	0.079	0.190	0.354	0.596	0.807
s19	0.014	0.055	0.147	0.355	0.623
s20	0.408	0.557	0.689	0.823	0.914
s21	0.022	0.064	0.144	0.311	0.533
s22	0.046	0.145	0.318	0.597	0.835
s23	0.012	0.042	0.107	0.260	0.484
s24	0.012	0.047	0.132	0.333	0.603
s25	0.098	0.227	0.407	0.653	0.849
s26	0.020	0.079	0.211	0.478	0.758
s27	0.227	0.357	0.497	0.667	0.810
s28	0.052	0.132	0.261	0.478	0.704
s29	0.011	0.053	0.163	0.421	0.723
s30	0.061	0.162	0.322	0.571	0.797
s31	0.306	0.483	0.653	0.824	0.930
s32	0.158	0.305	0.482	0.700	0.865
s33	0.002	0.018	0.088	0.333	0.691
s34	0.015	0.061	0.166	0.396	0.674
s35	0.134	0.272	0.445	0.670	0.847
s36	0.038	0.102	0.212	0.412	0.642
s37	0.036	0.112	0.253	0.504	0.757
s38	0.052	0.153	0.323	0.593	0.825
s39	0.104	0.229	0.398	0.632	0.826
s40	0.189	0.372	0.578	0.799	0.932
s41	0.290	0.464	0.635	0.810	0.922
s42	0.012	0.046	0.128	0.320	0.582
s43	0.001	0.012	0.064	0.273	0.626
s44	0.055	0.161	0.336	0.608	0.836
s45	0.072	0.190	0.370	0.632	0.845

Table 102- Difference between reproduced and original proportions for engineers or specialty consultants

Difference Between Reproduced And Original Proportions

THURST

	r1	r2	r3	r4	r5
s1	0.013	0.014	0.036	0.015	0.008
s2	0.006	0.013	0.028	0.026	0.015
s3	0.016	0.013	0.065	0.012	0.015
s4	0.011	0.007	0.051	0.014	0.022
s5	0.003	0.025	0.037	0.036	0.038
s6	0.031	0.059	0.008	0.021	0.004
s7	0.019	0.004	0.055	0.010	0.024
s8	0.035	0.046	0.050	0.034	0.046
s9	0.013	0.016	0.024	0.034	0.034
s10	0.005	0.020	0.030	0.026	0.007
s11	0.010	0.016	0.032	0.007	0.016
s12	0.003	0.025	0.052	0.010	0.017
s13	0.024	0.056	0.023	0.003	0.012
s14	0.012	0.005	0.028	0.036	0.011
s15	0.006	0.023	0.003	0.031	0.009
s16	0.019	0.019	0.051	0.002	0.021
s17	0.028	0.054	0.007	0.016	0.003
s18	0.002	0.001	0.011	0.042	0.017
s19	0.013	0.013	0.012	0.071	0.053
s20	0.017	0.003	0.000	0.042	0.022
s21	0.008	0.037	0.005	0.014	0.008
s22	0.008	0.010	0.021	0.016	0.016
s23	0.028	0.012	0.013	0.057	0.057
s24	0.015	0.007	0.003	0.009	0.005
s25	0.003	0.002	0.002	0.023	0.011
s26	0.006	0.002	0.008	0.008	0.002
s27	0.003	0.008	0.024	0.009	0.001
s28	0.002	0.016	0.018	0.059	0.039
s29	0.030	0.015	0.028	0.042	0.034
s30	0.020	0.014	0.079	0.037	0.014
s31	0.019	0.017	0.032	0.040	0.016
s32	0.018	0.006	0.063	0.002	0.013
s33	0.012	0.023	0.007	0.032	0.015
s34	0.002	0.007	0.004	0.045	0.028
s35	0.001	0.025	0.026	0.034	0.018
s36	0.016	0.021	0.023	0.034	0.047
s37	0.005	0.017	0.058	0.031	0.000
s38	0.012	0.009	0.026	0.015	0.001
s39	0.004	0.014	0.033	0.010	0.012
s40	0.013	0.020	0.017	0.015	0.001
s41	0.020	0.005	0.027	0.027	0.017
s42	0.015	0.008	0.006	0.050	0.039
s43	0.026	0.015	0.003	0.016	0.009
s44	0.012	0.025	0.025	0.027	0.001
s45	0.004	0.000	0.022	0.003	0.008

Table 103- Absolute difference between reproduced and original proportions averaged across categories for engineers or specialty consultants

Absolute Difference Between Reproduced And Original Proportions
Averaged Across Categories
THURST

	r1
s1	0.017
s2	0.018
s3	0.024
s4	0.021
s5	0.028
s6	0.025
s7	0.022
s8	0.042
s9	0.024
s10	0.018
s11	0.016
s12	0.021
s13	0.024
s14	0.018
s15	0.014
s16	0.022
s17	0.022
s18	0.015
s19	0.032
s20	0.017
s21	0.014
s22	0.014
s23	0.033
s24	0.008
s25	0.008
s26	0.005
s27	0.009
s28	0.027
s29	0.030
s30	0.033
s31	0.025
s32	0.021
s33	0.018
s34	0.017
s35	0.021
s36	0.028
s37	0.022
s38	0.013
s39	0.015
s40	0.013
s41	0.019
s42	0.024
s43	0.014
s44	0.018
s45	0.007

APPENDIX L

THURSTONE'S SUCCESSIVE INTERVAL PROCEDURE FOR GENERAL CONTRACTORS AND SUBCONTRACTORS

Table 104- Observed frequencies for general contractors and subcontractors

Obs	stimulus	_1	_2	_3	_4	_5	_6
1	1	4	3	7	11	8	5
2	2	1	5	5	7	10	10
3	3	6	4	5	10	6	7
4	4	1	2	2	10	9	14
5	5	1	1	2	6	14	14
6	6	3	7	8	6	6	8
7	7	2	4	8	11	8	5
8	8	1	4	8	8	9	8
9	9	0	1	2	4	12	19
10	10	3	4	5	7	14	5
11	11	1	0	2	14	11	10
12	12	3	3	8	8	7	9
13	13	2	3	2	9	10	12
14	14	2	2	3	5	15	11
15	15	4	9	4	7	8	6
16	16	3	7	8	6	6	8
17	17	5	5	5	7	13	3
18	18	6	2	5	9	11	5
19	19	1	0	3	10	10	14
20	20	10	4	8	8	6	2
21	21	0	0	2	4	8	24
22	22	2	4	8	9	9	6
23	23	0	0	2	7	14	15
24	24	2	0	3	7	12	14
25	25	4	3	4	15	7	5
26	26	2	3	1	5	12	15
27	27	7	7	4	6	10	4
28	28	3	3	3	4	13	12
29	29	0	2	6	6	12	12
30	30	3	3	3	8	10	11
31	31	14	7	7	4	4	2
32	32	2	4	8	4	6	14
33	33	0	0	1	10	10	17
34	34	3	1	5	6	11	12
35	35	7	1	3	10	8	9
36	36	3	1	3	7	15	9
37	37	2	3	7	9	9	8
38	38	1	2	5	8	9	13
39	39	3	4	8	8	9	6
40	40	10	2	6	4	8	8
41	41	9	5	9	6	4	5
42	42	1	3	6	4	10	14
43	43	1	0	2	8	9	18
44	44	5	6	3	10	5	9
45	45	3	3	3	7	13	9

Table 105- Matrix of proportions for general contractors and subcontractors

Matrix Of Proportions

PROP

	r1	r2	r3	r4	r5	r6
s1	0.11	0.08	0.18	0.29	0.21	0.13
s2	0.03	0.13	0.13	0.18	0.26	0.26
s3	0.16	0.11	0.13	0.26	0.16	0.18
s4	0.03	0.05	0.05	0.26	0.24	0.37
s5	0.03	0.03	0.05	0.16	0.37	0.37
s6	0.08	0.18	0.21	0.16	0.16	0.21
s7	0.05	0.11	0.21	0.29	0.21	0.13
s8	0.03	0.11	0.21	0.21	0.24	0.21
s9	0.00	0.03	0.05	0.11	0.32	0.50
s10	0.08	0.11	0.13	0.18	0.37	0.13
s11	0.03	0.00	0.05	0.37	0.29	0.26
s12	0.08	0.08	0.21	0.21	0.18	0.24
s13	0.05	0.08	0.05	0.24	0.26	0.32
s14	0.05	0.05	0.08	0.13	0.39	0.29
s15	0.11	0.24	0.11	0.18	0.21	0.16
s16	0.08	0.18	0.21	0.16	0.16	0.21
s17	0.13	0.13	0.13	0.18	0.34	0.08
s18	0.16	0.05	0.13	0.24	0.29	0.13
s19	0.03	0.00	0.08	0.26	0.26	0.37
s20	0.26	0.11	0.21	0.21	0.16	0.05
s21	0.00	0.00	0.05	0.11	0.21	0.63
s22	0.05	0.11	0.21	0.24	0.24	0.16
s23	0.00	0.00	0.05	0.18	0.37	0.39
s24	0.05	0.00	0.08	0.18	0.32	0.37
s25	0.11	0.08	0.11	0.39	0.18	0.13
s26	0.05	0.08	0.03	0.13	0.32	0.39
s27	0.18	0.18	0.11	0.16	0.26	0.11
s28	0.08	0.08	0.08	0.11	0.34	0.32
s29	0.00	0.05	0.16	0.16	0.32	0.32
s30	0.08	0.08	0.08	0.21	0.26	0.29
s31	0.37	0.18	0.18	0.11	0.11	0.05
s32	0.05	0.11	0.21	0.11	0.16	0.37
s33	0.00	0.00	0.03	0.26	0.26	0.45
s34	0.08	0.03	0.13	0.16	0.29	0.32
s35	0.18	0.03	0.08	0.26	0.21	0.24
s36	0.08	0.03	0.08	0.18	0.39	0.24
s37	0.05	0.08	0.18	0.24	0.24	0.21
s38	0.03	0.05	0.13	0.21	0.24	0.34
s39	0.08	0.11	0.21	0.21	0.24	0.16
s40	0.26	0.05	0.16	0.11	0.21	0.21
s41	0.24	0.13	0.24	0.16	0.11	0.13
s42	0.03	0.08	0.16	0.11	0.26	0.37
s43	0.03	0.00	0.05	0.21	0.24	0.47
s44	0.13	0.16	0.08	0.26	0.13	0.24
s45	0.08	0.08	0.08	0.18	0.34	0.24

Table 106- Matrix of cumulative proportions for general contractors and subcontractors

Matrix Of Cumulative Proportions

CUMPROP

	r1	r2	r3	r4	r5	r6
s1	0.105	0.184	0.368	0.658	0.868	1.000
s2	0.026	0.158	0.289	0.474	0.737	1.000
s3	0.158	0.263	0.395	0.658	0.816	1.000
s4	0.026	0.079	0.132	0.395	0.632	1.000
s5	0.026	0.053	0.105	0.263	0.632	1.000
s6	0.079	0.263	0.474	0.632	0.789	1.000
s7	0.053	0.158	0.368	0.658	0.868	1.000
s8	0.026	0.132	0.342	0.553	0.789	1.000
s9	0.000	0.026	0.079	0.184	0.500	1.000
s10	0.079	0.184	0.316	0.500	0.868	1.000
s11	0.026	0.026	0.079	0.447	0.737	1.000
s12	0.079	0.158	0.368	0.579	0.763	1.000
s13	0.053	0.132	0.184	0.421	0.684	1.000
s14	0.053	0.105	0.184	0.316	0.711	1.000
s15	0.105	0.342	0.447	0.632	0.842	1.000
s16	0.079	0.263	0.474	0.632	0.789	1.000
s17	0.132	0.263	0.395	0.579	0.921	1.000
s18	0.158	0.211	0.342	0.579	0.868	1.000
s19	0.026	0.026	0.105	0.368	0.632	1.000
s20	0.263	0.368	0.579	0.789	0.947	1.000
s21	0.000	0.000	0.053	0.158	0.368	1.000
s22	0.053	0.158	0.368	0.605	0.842	1.000
s23	0.000	0.000	0.053	0.237	0.605	1.000
s24	0.053	0.053	0.132	0.316	0.632	1.000
s25	0.105	0.184	0.289	0.684	0.868	1.000
s26	0.053	0.132	0.158	0.289	0.605	1.000
s27	0.184	0.368	0.474	0.632	0.895	1.000
s28	0.079	0.158	0.237	0.342	0.684	1.000
s29	0.000	0.053	0.211	0.368	0.684	1.000
s30	0.079	0.158	0.237	0.447	0.711	1.000
s31	0.368	0.553	0.737	0.842	0.947	1.000
s32	0.053	0.158	0.368	0.474	0.632	1.000
s33	0.000	0.000	0.026	0.289	0.553	1.000
s34	0.079	0.105	0.237	0.395	0.684	1.000
s35	0.184	0.211	0.289	0.553	0.763	1.000
s36	0.079	0.105	0.184	0.368	0.763	1.000
s37	0.053	0.132	0.316	0.553	0.789	1.000
s38	0.026	0.079	0.211	0.421	0.658	1.000
s39	0.079	0.184	0.395	0.605	0.842	1.000
s40	0.263	0.316	0.474	0.579	0.789	1.000
s41	0.237	0.368	0.605	0.763	0.868	1.000
s42	0.026	0.105	0.263	0.368	0.632	1.000
s43	0.026	0.026	0.079	0.289	0.526	1.000
s44	0.132	0.289	0.368	0.632	0.763	1.000
s45	0.079	0.158	0.237	0.421	0.763	1.000

Table 107- Matrix of probits for general contractors and subcontractors

Matrix Of Probits (Z-scores)

PROBITS

	r1	r2	r3	r4	r5
s1	-1.25	-.899	-.336	0.407	1.119
s2	.	-1.00	-.555	-.066	0.634
s3	-1.00	-.634	-.267	0.407	0.899
s4	.	-1.41	-1.12	-.267	0.336
s5	.	-1.62	-1.25	-.634	0.336
s6	-1.41	-.634	-.066	0.336	0.805
s7	-1.62	-1.00	-.336	0.407	1.119
s8	.	-1.12	-.407	0.132	0.805
s9	.	.	-1.41	-.899	-.000
s10	-1.41	-.899	-.480	-.000	1.119
s11	.	.	-1.41	-.132	0.634
s12	-1.41	-1.00	-.336	0.199	0.716
s13	-1.62	-1.12	-.899	-.199	0.480
s14	-1.62	-1.25	-.899	-.480	0.555
s15	-1.25	-.407	-.132	0.336	1.003
s16	-1.41	-.634	-.066	0.336	0.805
s17	-1.12	-.634	-.267	0.199	1.412
s18	-1.00	-.805	-.407	0.199	1.119
s19	.	.	-1.25	-.336	0.336
s20	-.634	-.336	0.199	0.805	1.620
s21	.	.	-1.62	-1.00	-.336
s22	-1.62	-1.00	-.336	0.267	1.003
s23	.	.	-1.62	-.716	0.267
s24	-1.62	-1.62	-1.12	-.480	0.336
s25	-1.25	-.899	-.555	0.480	1.119
s26	-1.62	-1.12	-1.00	-.555	0.267
s27	-.899	-.336	-.066	0.336	1.252
s28	-1.41	-1.00	-.716	-.407	0.480
s29	.	-1.62	-.805	-.336	0.480
s30	-1.41	-1.00	-.716	-.132	0.555
s31	-.336	0.132	0.634	1.003	1.620
s32	-1.62	-1.00	-.336	-.066	0.336
s33	.	.	.	-.555	0.132
s34	-1.41	-1.25	-.716	-.267	0.480
s35	-.899	-.805	-.555	0.132	0.716
s36	-1.41	-1.25	-.899	-.336	0.716
s37	-1.62	-1.12	-.480	0.132	0.805
s38	.	-1.41	-.805	-.199	0.407
s39	-1.41	-.899	-.267	0.267	1.003
s40	-.634	-.480	-.066	0.199	0.805
s41	-.716	-.336	0.267	0.716	1.119
s42	.	-1.25	-.634	-.336	0.336
s43	.	.	-1.41	-.555	0.066
s44	-1.12	-.555	-.336	0.336	0.716
s45	-1.41	-1.00	-.716	-.199	0.716

Table 108- Matrix of aprobits for general contractors and subcontractors

APROBITS

Matrix Of Probit Differences

	r1	r2	r3	r4
s1	0.35	0.56	0.74	0.71
s2	.	0.45	0.49	0.70
s3	0.37	0.37	0.67	0.49
s4	.	0.29	0.85	0.60
s5	.	0.37	0.62	0.97
s6	0.78	0.57	0.40	0.47
s7	0.62	0.67	0.74	0.71
s8	.	0.71	0.54	0.67
s9	.	.	0.51	0.90
s10	0.51	0.42	0.48	1.12
s11	.	.	1.28	0.77
s12	0.41	0.67	0.54	0.52
s13	0.50	0.22	0.70	0.68
s14	0.37	0.35	0.42	1.03
s15	0.85	0.27	0.47	0.67
s16	0.78	0.57	0.40	0.47
s17	0.49	0.37	0.47	1.21
s18	0.20	0.40	0.61	0.92
s19	.	.	0.92	0.67
s20	0.30	0.54	0.61	0.82
s21	.	.	0.62	0.67
s22	0.62	0.67	0.60	0.74
s23	.	.	0.90	0.98
s24	0.00	0.50	0.64	0.82
s25	0.35	0.34	1.03	0.64
s26	0.50	0.12	0.45	0.82
s27	0.56	0.27	0.40	0.92
s28	0.41	0.29	0.31	0.89
s29	.	0.82	0.47	0.82
s30	0.41	0.29	0.58	0.69
s31	0.47	0.50	0.37	0.62
s32	0.62	0.67	0.27	0.40
s33	.	.	.	0.69
s34	0.16	0.54	0.45	0.75
s35	0.09	0.25	0.69	0.58
s36	0.16	0.35	0.56	1.05
s37	0.50	0.64	0.61	0.67
s38	.	0.61	0.61	0.61
s39	0.51	0.63	0.53	0.74
s40	0.15	0.41	0.27	0.61
s41	0.38	0.60	0.45	0.40
s42	.	0.62	0.30	0.67
s43	.	.	0.86	0.62
s44	0.56	0.22	0.67	0.38
s45	0.41	0.29	0.52	0.92

Table 109- Category boundaries for general contractors and subcontractors

Category Boundaries

CATBOUND

r1	r2	r3	r4	r5
0.000	1.000	1.855	2.729	3.704

Table 110- Scale values for contractors and subcontractors

Scale Values

	SCALE
s1	2.149
s2	2.733
s3	2.083
s4	3.228
s5	3.414
s6	2.186
s7	2.238
s8	2.532
s9	3.767
s10	2.369
s11	3.038
s12	2.473
s13	3.056
s14	3.174
s15	2.014
s16	2.186
s17	1.984
s18	2.170
s19	3.250
s20	1.322
s21	4.183
s22	2.331
s23	3.438
s24	3.491
s25	2.189
s26	3.549
s27	1.753
s28	3.130
s29	3.079
s30	2.887
s31	0.691
s32	2.871
s33	3.516
s34	3.074
s35	2.477
s36	2.982
s37	2.542
s38	3.067
s39	2.256
s40	1.948
s41	1.450
s42	3.158
s43	3.558
s44	2.241
s45	2.800

Table 111- Standard deviations of the discriminal process distributions of the attributes for general contractors and subcontractors

Stimulus STDs

	SCALESTD
s1	1.514
s2	1.660
s3	1.889
s4	1.472
s5	1.378
s6	1.689
s7	1.328
s8	1.425
s9	1.303
s10	1.529
s11	0.908
s12	1.677
s13	1.784
s14	1.780
s15	1.733
s16	1.689
s17	1.546
s18	1.743
s19	1.168
s20	1.620
s21	1.440
s22	1.403
s23	0.980
s24	1.815
s25	1.496
s26	2.099
s27	1.830
s28	2.080
s29	1.328
s30	1.901
s31	1.910
s32	1.884
s33	1.419
s34	1.920
s35	2.198
s36	1.766
s37	1.500
s38	1.483
s39	1.524
s40	2.572
s41	1.939
s42	1.773
s43	1.255
s44	2.003
s45	1.802

Table 112- Reproduced cumulative proportions aprobits for general contractors and subcontractors

Reproduced Cumulative Proportions
APROBITS

	r1	r2	r3	r4	r5
s1	0.078	0.224	0.423	0.649	0.848
s2	0.050	0.148	0.299	0.499	0.721
s3	0.135	0.283	0.452	0.634	0.804
s4	0.014	0.065	0.176	0.367	0.627
s5	0.007	0.040	0.129	0.310	0.583
s6	0.098	0.241	0.422	0.626	0.816
s7	0.046	0.176	0.387	0.644	0.865
s8	0.038	0.141	0.318	0.555	0.795
s9	0.002	0.017	0.071	0.213	0.481
s10	0.061	0.185	0.369	0.593	0.809
s11	0.000	0.012	0.096	0.367	0.768
s12	0.070	0.190	0.356	0.561	0.768
s13	0.043	0.125	0.251	0.427	0.642
s14	0.037	0.111	0.230	0.401	0.617
s15	0.123	0.279	0.463	0.660	0.835
s16	0.098	0.241	0.422	0.626	0.816
s17	0.100	0.262	0.467	0.685	0.867
s18	0.107	0.251	0.428	0.626	0.811
s19	0.003	0.027	0.116	0.328	0.651
s20	0.207	0.421	0.629	0.807	0.929
s21	0.002	0.014	0.053	0.156	0.370
s22	0.048	0.171	0.367	0.612	0.836
s23	0.000	0.006	0.053	0.234	0.607
s24	0.027	0.085	0.184	0.337	0.547
s25	0.072	0.213	0.412	0.641	0.844
s26	0.045	0.112	0.210	0.348	0.529
s27	0.169	0.340	0.522	0.703	0.857
s28	0.066	0.153	0.270	0.423	0.609
s29	0.010	0.059	0.178	0.396	0.681
s30	0.064	0.160	0.294	0.467	0.666
s31	0.359	0.564	0.729	0.857	0.943
s32	0.064	0.160	0.295	0.470	0.671
s33	0.007	0.038	0.121	0.289	0.553
s34	0.055	0.140	0.263	0.429	0.629
s35	0.130	0.251	0.389	0.545	0.712
s36	0.046	0.131	0.262	0.443	0.659
s37	0.045	0.152	0.324	0.550	0.781
s38	0.019	0.082	0.207	0.410	0.666
s39	0.069	0.205	0.396	0.622	0.829
s40	0.224	0.356	0.486	0.619	0.753
s41	0.227	0.408	0.583	0.745	0.877
s42	0.037	0.112	0.231	0.404	0.621
s43	0.002	0.021	0.087	0.254	0.546
s44	0.132	0.268	0.424	0.596	0.767
s45	0.060	0.159	0.300	0.484	0.692

Table 113- Difference between reproduced and original proportions for general contractors and subcontractors

Difference Between Reproduced And Original Proportions

THURST

	r1	r2	r3	r4	r5
s1	0.027	0.040	0.055	0.009	0.021
s2	0.024	0.010	0.009	0.025	0.016
s3	0.023	0.020	0.057	0.024	0.011
s4	0.012	0.014	0.044	0.027	0.005
s5	0.020	0.013	0.024	0.046	0.048
s6	0.019	0.022	0.051	0.005	0.026
s7	0.007	0.018	0.018	0.014	0.003
s8	0.012	0.010	0.025	0.002	0.005
s9	0.002	0.009	0.008	0.029	0.019
s10	0.018	0.001	0.053	0.093	0.060
s11	0.026	0.014	0.017	0.081	0.031
s12	0.009	0.032	0.012	0.018	0.005
s13	0.009	0.007	0.066	0.006	0.042
s14	0.015	0.006	0.045	0.086	0.094
s15	0.017	0.063	0.016	0.028	0.007
s16	0.019	0.022	0.051	0.005	0.026
s17	0.032	0.001	0.072	0.106	0.054
s18	0.051	0.040	0.086	0.047	0.058
s19	0.024	0.001	0.011	0.041	0.019
s20	0.056	0.053	0.050	0.018	0.018
s21	0.002	0.014	0.000	0.002	0.001
s22	0.004	0.013	0.001	0.006	0.006
s23	0.000	0.006	0.000	0.002	0.001
s24	0.025	0.032	0.052	0.021	0.085
s25	0.034	0.029	0.122	0.043	0.024
s26	0.007	0.019	0.052	0.058	0.076
s27	0.015	0.028	0.049	0.072	0.038
s28	0.013	0.005	0.033	0.081	0.076
s29	0.010	0.006	0.032	0.028	0.003
s30	0.015	0.002	0.057	0.019	0.044
s31	0.010	0.012	0.008	0.015	0.005
s32	0.011	0.002	0.073	0.004	0.039
s33	0.007	0.038	0.095	0.000	0.000
s34	0.024	0.035	0.026	0.034	0.056
s35	0.054	0.040	0.099	0.007	0.052
s36	0.033	0.026	0.078	0.075	0.105
s37	0.008	0.020	0.008	0.003	0.009
s38	0.007	0.003	0.004	0.011	0.008
s39	0.010	0.021	0.002	0.016	0.013
s40	0.039	0.040	0.012	0.040	0.037
s41	0.010	0.040	0.023	0.018	0.009
s42	0.011	0.007	0.032	0.036	0.011
s43	0.024	0.006	0.009	0.035	0.020
s44	0.000	0.022	0.055	0.035	0.004
s45	0.019	0.001	0.063	0.063	0.071

Table 114- Absolute difference between reproduced and original proportions averaged across categories for general contractors and subcontractors

Absolute Difference Between Reproduced And Original Proportions
Averaged Across Categories
THURST

	r1
s1	0.030
s2	0.017
s3	0.027
s4	0.020
s5	0.030
s6	0.025
s7	0.012
s8	0.011
s9	0.013
s10	0.045
s11	0.034
s12	0.015
s13	0.026
s14	0.049
s15	0.026
s16	0.025
s17	0.053
s18	0.057
s19	0.019
s20	0.039
s21	0.004
s22	0.006
s23	0.002
s24	0.043
s25	0.051
s26	0.043
s27	0.040
s28	0.042
s29	0.016
s30	0.027
s31	0.010
s32	0.026
s33	0.028
s34	0.035
s35	0.050
s36	0.063
s37	0.009
s38	0.007
s39	0.012
s40	0.034
s41	0.020
s42	0.019
s43	0.019
s44	0.023
s45	0.044

APPENDIX M

ANALYSIS OF VARIANCE INTEGRATION ATTRIBUTES

Attributes that have a significant difference are:

Table 115-Performance oriented culture ANOVA

ANOVA

q10_performance_culture_integration

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	24.737	3	8.246	3.517	.016
Within Groups	452.431	193	2.344		
Total	477.168	196			

Table 116- Performance oriented culture multiple comparisons Tukey test

Multiple Comparisons

q10_performance_culture_integration
Tukey HSD

(I) q1_company_role	(J) q1_company_role	Mean Difference (I-J)	Std. Error	Sig.
Arquitect	Engineer or Specialty Consultant	.61459	.28029	.129
	Facility Manager +Owner	.07882	.34034	.996
	General Contractor + Subs	.90462*	.32710	.031
Engineer or Specialty Consultant	Arquitect	-.61459	.28029	.129
	Facility Manager +Owner	-.53577	.31722	.332
	General Contractor + Subs	.29002	.30296	.774
Facility Manager +Owner	Arquitect	-.07882	.34034	.996
	Engineer or Specialty Consultant	.53577	.31722	.332
	General Contractor + Subs	.82579	.35924	.102
General Contractor + Subs	Arquitect	-.90462*	.32710	.031
	Engineer or Specialty Consultant	-.29002	.30296	.774
	Facility Manager +Owner	-.82579	.35924	.102

*. The mean difference is significant at the 0.05 level.

Table 117- Mutual respect ANOVA

ANOVA

q11_mutual_respect_integration

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	13.650	3	4.550	2.921	.035
Within Groups	302.214	194	1.558		
Total	315.864	197			

Table 118- Mutual respect multiple comparisons Tukey test

Multiple Comparisons

q11_mutual_respect_integration
Tukey HSD

(I) q1_company_role	(J) q1_company_role	Mean Difference (I-J)	Std. Error	Sig.
Arquitect	Engineer or Specialty Consultant	.54054	.22849	.087
	Facility Manager +Owner	-.08824	.27744	.989
	General Contractor + Subs	.35000	.26477	.550
Engineer or Specialty Consultant	Arquitect	-.54054	.22849	.087
	Facility Manager +Owner	-.62878	.25859	.075
	General Contractor + Subs	-.19054	.24494	.864
Facility Manager +Owner	Arquitect	.08824	.27744	.989
	Engineer or Specialty Consultant	.62878	.25859	.075
	General Contractor + Subs	.43824	.29114	.436
General Contractor + Subs	Arquitect	-.35000	.26477	.550
	Engineer or Specialty Consultant	.19054	.24494	.864
	Facility Manager +Owner	-.43824	.29114	.436

Table 119- Shared BIM ANOVA

ANOVA

q24_shared_bim_integration

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	40.829	3	13.610	4.315	.006
Within Groups	605.595	192	3.154		
Total	646.423	195			

Table 120- Shared BIM multiple comparisons Tukey test

Multiple Comparisons

q24_shared_bim_integration
Tukey HSD

(I) q1_company_role	(J) q1_company_role	Mean Difference (I-J)	Std. Error	Sig.
Arquitect	Engineer or Specialty Consultant	1.13644*	.32602	.003
	Facility Manager +Owner	.66706	.39478	.332
	General Contractor + Subs	.95590	.37942	.060
Engineer or Specialty Consultant	Arquitect	-1.13644*	.32602	.003
	Facility Manager +Owner	-.46938	.36875	.581
	General Contractor + Subs	-.18054	.35225	.956
Facility Manager +Owner	Arquitect	-.66706	.39478	.332
	Engineer or Specialty Consultant	.46938	.36875	.581
	General Contractor + Subs	.28884	.41671	.900
General Contractor + Subs	Arquitect	-.95590	.37942	.060
	Engineer or Specialty Consultant	.18054	.35225	.956
	Facility Manager +Owner	-.28884	.41671	.900

*. The mean difference is significant at the 0.05 level.

Table 121- Involvement of acknowledgeable owner

ANOVA

q25_owner_involvement_integration

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	27.635	3	9.212	3.266	.022
Within Groups	544.335	193	2.820		
Total	571.970	196			

Table 122- Owner involvement of a knowledgeable owner

Multiple Comparisons

q25_owner_involvement_integration
Tukey HSD

(I) q1_company_role	(J) q1_company_role	Mean Difference (I-J)	Std. Error	Sig.
Arquitect	Engineer or Specialty Consultant	.41405	.30744	.534
	Facility Manager +Owner	-.31647	.37331	.832
	General Contractor + Subs	.79590	.35878	.122
Engineer or Specialty Consultant	Arquitect	-.41405	.30744	.534
	Facility Manager +Owner	-.73052	.34795	.157
	General Contractor + Subs	.38184	.33231	.660
Facility Manager +Owner	Arquitect	.31647	.37331	.832
	Engineer or Specialty Consultant	.73052	.34795	.157
	General Contractor + Subs	1.11237*	.39404	.027
General Contractor + Subs	Arquitect	-.79590	.35878	.122
	Engineer or Specialty Consultant	-.38184	.33231	.660
	Facility Manager +Owner	-1.11237*	.39404	.027

*. The mean difference is significant at the 0.05 level.

Table 123- Project delivery method selection ANOVA

ANOVA

q39_delivery_method_integration

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	24.279	3	8.093	2.712	.046
Within Groups	575.853	193	2.984		
Total	600.132	196			

Table 124- Project delivery method selection multiple comparisons Tukey test

Multiple Comparisons

q39_delivery_method_integration
Tukey HSD

(I) q1_company_role	(J) q1_company_role	Mean Difference (I-J)	Std. Error	Sig.
Arquitect	Engineer or Specialty Consultant	.71333	.31537	.111
	Facility Manager +Owner	.37529	.38397	.762
	General Contractor + Subs	-.12316	.37174	.987
Engineer or Specialty Consultant	Arquitect	-.71333	.31537	.111
	Facility Manager +Owner	-.33804	.35712	.780
	General Contractor + Subs	-.83649	.34395	.075
Facility Manager +Owner	Arquitect	-.37529	.38397	.762
	Engineer or Specialty Consultant	.33804	.35712	.780
	General Contractor + Subs	-.49845	.40777	.613
General Contractor + Subs	Arquitect	.12316	.37174	.987
	Engineer or Specialty Consultant	.83649	.34395	.075
	Facility Manager +Owner	.49845	.40777	.613

Table 125- Efficient coordination ANOVA

ANOVA

q42_efficient_coordination_integration

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	15.622	3	5.207	3.027	.031
Within Groups	333.692	194	1.720		
Total	349.313	197			

Table 126- Efficient coordination multiple comparisons Tukey test

Multiple Comparisons

q42_efficient_coordination_integration
Tukey HSD

(I) q1_company_role	(J) q1_company_role	Mean Difference (I-J)	Std. Error	Sig.
Arquitect	Engineer or Specialty Consultant	.63243*	.24009	.045
	Facility Manager +Owner	.31765	.29153	.696
	General Contractor + Subs	.70000	.27821	.061
Engineer or Specialty Consultant	Arquitect	-.63243*	.24009	.045
	Facility Manager +Owner	-.31479	.27172	.654
	General Contractor + Subs	.06757	.25738	.994
Facility Manager +Owner	Arquitect	-.31765	.29153	.696
	Engineer or Specialty Consultant	.31479	.27172	.654
	General Contractor + Subs	.38235	.30593	.596
General Contractor + Subs	Arquitect	-.70000	.27821	.061
	Engineer or Specialty Consultant	-.06757	.25738	.994
	Facility Manager +Owner	-.38235	.30593	.596

*. The mean difference is significant at the 0.05 level.

Table 127- Subcontractor involvement ANOVA

ANOVA

q44_sub_involvement_integration

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	16.479	3	5.493	2.767	.043
Within Groups	383.135	193	1.985		
Total	399.614	196			

Table 128- Subcontractor involvement multiple comparisons Tukey test

Multiple Comparisons

q44_sub_involvement_integration
Tukey HSD

(I) q1_company_role	(J) q1_company_role	Mean Difference (I-J)	Std. Error	Sig.
Architect	Engineer or Specialty Consultant	-.13405	.25793	.954
	Facility Manager +Owner	-.66824	.31319	.146
	General Contractor + Subs	-.66974	.30101	.120
Engineer or Specialty Consultant	Architect	.13405	.25793	.954
	Facility Manager +Owner	-.53418	.29191	.262
	General Contractor + Subs	-.53569	.27880	.222
Facility Manager +Owner	Architect	.66824	.31319	.146
	Engineer or Specialty Consultant	.53418	.29191	.262
	General Contractor + Subs	-.00151	.33059	1.000
General Contractor + Subs	Architect	.66974	.30101	.120
	Engineer or Specialty Consultant	.53569	.27880	.222
	Facility Manager +Owner	.00151	.33059	1.000

Table 129- Open book accounting ANOVA

ANOVA

q48_open_book_accounting_integration

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	35.045	3	11.682	2.691	.048
Within Groups	837.828	193	4.341		
Total	872.873	196			

Table 130- Open book accounting multiple comparisons Tukey test

Multiple Comparisons

q48_open_book_accounting_integration
Tukey HSD

(I) q1_company_role	(J) q1_company_role	Mean Difference (I-J)	Std. Error	Sig.
Arquitect	Engineer or Specialty Consultant	.98649	.38142	.051
	Facility Manager +Owner	.14706	.46314	.989
	General Contractor + Subs	.65385	.44512	.458
Engineer or Specialty Consultant	Arquitect	-.98649	.38142	.051
	Facility Manager +Owner	-.83943	.43167	.213
	General Contractor + Subs	-.33264	.41228	.851
Facility Manager +Owner	Arquitect	-.14706	.46314	.989
	Engineer or Specialty Consultant	.83943	.43167	.213
	General Contractor + Subs	.50679	.48886	.728
General Contractor + Subs	Arquitect	-.65385	.44512	.458
	Engineer or Specialty Consultant	.33264	.41228	.851
	Facility Manager +Owner	-.50679	.48886	.728

The attributes that are not statistically significant are:

Table 131- ANOVA for non-significant differences

q8_adequate_risk_management_integration

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	6.760	3	2.253	.854	.466
Within Groups	509.240	193	2.639		
Total	516.000	196			

q9_int_conflict_resolution_integration

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	7.851	3	2.617	1.449	.230
Within Groups	348.636	193	1.806		
Total	356.487	196			

q12_trust_integration

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	10.064	3	3.355	1.975	.119
Within Groups	327.905	193	1.699		
Total	337.970	196			

q13_benefits_all_members_intergation

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	4.151	3	1.384	.442	.723
Within Groups	606.723	194	3.127		
Total	610.874	197			

q14_training_education_integration

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	10.490	3	3.497	1.372	.253
Within Groups	491.896	193	2.549		
Total	502.386	196			

q15_innovation_integration

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	13.596	3	4.532	1.728	.163
Within Groups	508.793	194	2.623		
Total	522.389	197			

Table 131 - Continued

q16_early_key_participants_integration

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	8.519	3	2.840	1.682	.172
Within Groups	327.460	194	1.688		
Total	335.980	197			

q17_teambuilding_teamwork_integration

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	18.056	3	6.019	2.461	.064
Within Groups	471.964	193	2.445		
Total	490.020	196			

q18_team_selection_integration

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3.702	3	1.234	.662	.576
Within Groups	361.672	194	1.864		
Total	365.374	197			

q19_collaborative_decision_integration

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	4.460	3	1.487	.576	.632
Within Groups	500.858	194	2.582		
Total	505.318	197			

q20_intensified_planning_integration

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	5.291	3	1.764	.763	.516
Within Groups	446.262	193	2.312		
Total	451.553	196			

q21_early_goal_definition_integration

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.399	3	.133	.074	.974
Within Groups	344.454	193	1.785		
Total	344.853	196			

q22_reward_structure_integration

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	6.117	3	2.039	.670	.572
Within Groups	584.557	192	3.045		
Total	590.673	195			

q23_appr_use_technology_integration

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	14.581	3	4.860	2.075	.105
Within Groups	452.119	193	2.343		
Total	466.701	196			

q26_owner_commitment_integration

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	6.701	3	2.234	1.638	.182
Within Groups	263.126	193	1.363		
Total	269.827	196			

q27_one_team_location_integration

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	35.046	3	11.682	2.488	.062
Within Groups	906.172	193	4.695		
Total	941.218	196			

Table 131 - Continued

q28_open_communication_integration

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	9.173	3	3.058	2.499	.061
Within Groups	234.929	192	1.224		
Total	244.102	195			

q29_project_type_experience_integration

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	13.285	3	4.428	2.095	.102
Within Groups	407.882	193	2.113		
Total	421.168	196			

q30_organization_leadership_integration

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1.049	3	.350	.284	.837
Within Groups	237.337	193	1.230		
Total	238.386	196			

q31_information_share_integration

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	7.489	3	2.496	1.728	.163
Within Groups	277.384	192	1.445		
Total	284.872	195			

q32_continuous_improvement_integration

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	8.520	3	2.840	1.158	.327
Within Groups	473.449	193	2.453		
Total	481.970	196			

q33_knowledge_sharing_integration

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	5.988	3	1.996	1.055	.369
Within Groups	365.138	193	1.892		
Total	371.127	196			

q34_eliminate_multilayer_sub_integration

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3.800	3	1.267	.297	.828
Within Groups	828.786	194	4.272		
Total	832.586	197			

q35_common_goals_integration

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	5.106	3	1.702	.757	.520
Within Groups	433.990	193	2.249		
Total	439.096	196			

q36_accountability_integration

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	4.134	3	1.378	.816	.487
Within Groups	327.730	194	1.689		
Total	331.864	197			

q37_contracting_structure_integration

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	12.353	3	4.118	1.637	.182
Within Groups	485.372	193	2.515		
Total	497.726	196			

Table 131 - Continued

q38_facilitator_integration

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	27.715	3	9.238	1.790	.151
Within Groups	991.158	192	5.162		
Total	1018.872	195			

q40_adequate_resources_integration

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3.540	3	1.180	.992	.398
Within Groups	230.824	194	1.190		
Total	234.364	197			

q41_top_management_intgration

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	7.845	3	2.615	1.419	.238
Within Groups	357.428	194	1.842		
Total	365.273	197			

q42_long_term_commit_integration

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	7.325	3	2.442	.661	.577
Within Groups	716.897	194	3.695		
Total	724.222	197			

q43_understanding_others_integration

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3.863	3	1.288	.742	.528
Within Groups	336.481	194	1.734		
Total	340.343	197			

q45_facility_manager_involv_integration

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	12.002	3	4.001	1.260	.289
Within Groups	615.841	194	3.174		
Total	627.843	197			

q46_less_reliance_contracts_integration

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	7.357	3	2.452	.492	.688
Within Groups	961.912	193	4.984		
Total	969.269	196			

q49_personal_attitude_integration

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	4.248	3	1.416	.710	.547
Within Groups	386.843	194	1.994		
Total	391.091	197			

q50_timely_responsivness_integration

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.195	3	.065	.049	.985
Within Groups	253.623	193	1.314		
Total	253.817	196			

q51_company_culture_integration

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	10.955	3	3.652	1.239	.297
Within Groups	568.964	193	2.948		
Total	579.919	196			

Table 131 - Continued

q52_team_experience_integration

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	8.908	3	2.969	1.254	.291
Within Groups	459.238	194	2.367		
Total	468.146	197			

APPENDIX N

ANALYSIS OF MEANS OF THE INTEGRATION ATTRIBUTES ON PERFORMANCE

Table 132- Descriptive statistics of the potential impact of each integration attribute on cost

Cost

Descriptive Statistics

	N	Mean		Std. Deviation	Variance
	Statistic	Statistic	Std. Error	Statistic	Statistic
q59_adequate_risk_management_cost	49	7.0816	.22368	1.56574	2.452
q60_internal_conflict_resolution_cost	34	7.4118	.18937	1.10420	1.219
q61_performance_culture_cost	26	7.7308	.20424	1.04145	1.085
q62_trust_cost	40	6.7750	.28530	1.80438	3.256
q63_clear_benefits_for_all_cost	24	7.4167	.22455	1.10007	1.210
q64_training_education_cost	25	8.0400	.13515	.67577	.457
q65_innovation_innovative_thinking_cost	24	6.9167	.22455	1.10007	1.210
q66_early_key_project_participants_cost	34	7.6176	.16360	.95393	.910
q67_team_building_teamwork_cost	42	6.7857	.26950	1.74657	3.051
q68_team_selection_criteria_cost	22	7.8182	.26836	1.25874	1.584
q69_collaborative_decision_making_cost	21	7.3810	.29662	1.35927	1.848
q70_planning_cost	23	6.6087	.37055	1.77711	3.158
q71_early_goal_definition_cost	36	6.7500	.24029	1.44173	2.079
q72_reward_structure_linked_to_success_cost	19	7.4737	.27960	1.21876	1.485
q73_appropriate_use_of_technology_cost	21	7.7619	.21718	.99523	.990
q74_shared_bim_cost	17	7.0588	.41542	1.71284	2.934
q75_intensive_owner_involvement_cost	31	7.1613	.27079	1.50769	2.273
q76_owner_commitment_cost	29	6.9310	.33267	1.79147	3.209
q77_location_cost	28	6.8929	.41576	2.19999	4.840
q78_open_continuous_communication_cost	38	7.1579	.26001	1.60281	2.569
q79_project_type_experience_cost	21	7.1429	.10433	.47809	.229
q80_project_manager_leadership_cost	20	7.5500	.19835	.88704	.787
q81_information_share_cost	27	7.5556	.29878	1.55250	2.410
q82_continuous_improvement_cost	27	7.7037	.25495	1.32476	1.755
q83_knowledge_share_cost	32	7.0938	.27445	1.55251	2.410
q84_eliminate_multilayer_subcontractors_cost	24	6.5417	.36105	1.76879	3.129
q85_common_goals_cost	76	3.6053	.43045	3.75261	14.082
q86_responsibilities_accountability_cost	23	7.6087	.24137	1.15755	1.340
q87_contracting_structure_cost	30	7.9000	.19971	1.09387	1.197
q88_facilitator_cost	24	5.2500	.41811	2.04833	4.196
q89_project_delivery_method_cost	20	7.2500	.32343	1.44641	2.092
q90_adequate_resources_cost	20	6.4000	.35094	1.56945	2.463
q91_top_management_support_cost	15	6.4667	.54219	2.09989	4.410
q92_long_term_commitment_cost	27	7.1481	.24866	1.29210	1.670
q93_efficient_coordination_cost	24	7.4583	.27570	1.35066	1.824
q94_understanding_others_needs_cost	38	6.5526	.27379	1.68775	2.849
q95_subcontractor_involvement_cost	24	8.0833	.23248	1.13890	1.297
q96_facility_manager_involvement_cost	23	6.9565	.31105	1.49174	2.225
q97_less_reliance_contracts_cost	18	6.6111	.42885	1.81947	3.310
q98_open_book_accounting_cost	21	8.0000	.24881	1.14018	1.300
q99_personal_attitude_commitment_cost	18	7.0556	.42374	1.79778	3.232
q100_timely_responsiveness_cost	21	6.4286	.33503	1.53530	2.357
q101_company_culture_cost	27	7.2222	.24069	1.25064	1.564
q102_team_experience_cost	22	7.9091	.15994	.75018	.563
Valid N (listwise)	0				

Table 133- Descriptive statistics of the potential impact of each integration attribute on time

Time

Descriptive Statistics

	N	Mean		Std. Deviation	Variance
	Statistic	Statistic	Std. Error	Statistic	Statistic
q59_adequate_risk_management_time	48	6.8542	.24551	1.70093	2.893
q60_internal_conflict_resolution_time	34	7.2941	.24080	1.40409	1.971
q61_performance_culture_time	26	7.5769	.17692	.90213	.814
q61_mutual_respect_time	35	7.2000	.20416	1.20782	1.459
q62_trust_time	39	6.6154	.25349	1.58306	2.506
q63_clear_benefits_for_all_time	24	7.5833	.31229	1.52990	2.341
q64_training_education_time	25	7.6400	.19900	.99499	.990
q65_innovation_innovative_thinking_time	24	7.2500	.24265	1.18872	1.413
q67_team_building_teamwork_time	43	7.1628	.23039	1.51076	2.282
q68_team_selection_criteria_time	22	7.7727	.26262	1.23179	1.517
q69_collaborative_decision_making_time	21	7.7143	.25951	1.18924	1.414
q70_planning_time	23	6.7391	.40363	1.93573	3.747
q71_early_goal_definition_time	35	6.5714	.28191	1.66779	2.782
q72_reward_structure_linked_to_success_time	18	7.2222	.30844	1.30859	1.712
q73_appropriate_use_of_technology_time	21	7.7143	.24046	1.10195	1.214
q74_shared_bim_time	17	7.1765	.34551	1.42457	2.029
q75_intensive_owner_involvement_time	31	7.6129	.24397	1.35837	1.845
q76_owner_commitment_time	29	6.9655	.33470	1.80243	3.249
q77_location_time	28	6.9286	.39147	2.07147	4.291
q78_open_continuous_communication_time	38	7.0000	.27971	1.72423	2.973
q79_project_type_experience_time	21	7.2857	.12234	.56061	.314
q80_project_manager_leadership_time	20	7.7000	.14690	.65695	.432
q81_information_share_time	27	7.7407	.30001	1.55891	2.430
q82_continuous_improvement_time	27	7.7037	.26048	1.35348	1.832
q83_knowledge_share_time	32	7.5313	.31426	1.77772	3.160
q84_eliminate_multilayer_subcontractors_time	25	6.6000	.33166	1.65831	2.750
q85_common_goals_time	75	3.4000	.42490	3.67975	13.541
q86_responsibilities_accountability_time	23	7.7391	.22857	1.09617	1.202
q87_contracting_structure_time	31	7.5806	.23996	1.33602	1.785
q88_facilitator_time	24	5.9167	.39433	1.93181	3.732
q89_project_delivery_method_time	19	7.7368	.22739	.99119	.982
q90_adequate_resources_time	20	7.3000	.39135	1.75019	3.063
q91_top_management_support_time	15	7.1333	.27372	1.06010	1.124
q92_long_term_commitment_time	27	7.2222	.22854	1.18754	1.410
q93_efficient_coordination_time	24	7.9167	.16936	.82970	.688
q94_understanding_others_needs_time	38	7.2368	.24277	1.49656	2.240
q95_subcontractor_involvement_time	24	8.2917	.21264	1.04170	1.085
q96_facility_manager_involvement_time	23	7.3913	.31270	1.49967	2.249
q97_less_reliance_contracts_time	18	7.5556	.24551	1.04162	1.085
q98_open_book_accounting_time	23	6.8696	.38910	1.86607	3.482
q99_personal_attitude_commitment_time	18	7.7778	.23647	1.00326	1.007
q100_timely_responsiveness_time	21	7.0000	.32367	1.48324	2.200
q101_company_culture_time	26	7.4231	.25524	1.30148	1.694
q102_team_experience_time	22	7.2727	.18820	.88273	.779
Valid N (listwise)	0				

Table 134- Descriptive statistics of the potential impact of each integration attribute on health and safety

Health and Safety

Descriptive Statistics

	N	Maximum	Mean		Std. Deviation
	Statistic	Statistic	Statistic	Std. Error	Statistic
q59_adequate_risk_management_health_safety	48	9.00	6.8542	.32751	2.26903
q60_internal_conflict_resolution_health_safety	34	9.00	7.1765	.31727	1.84999
q61_performance_culture_health_safety	26	9.00	7.2308	.36504	1.86135
q61_mutual_respect_health_safety	34	9.00	6.8529	.30190	1.76038
q62_trust_health_safety	40	9.00	5.5750	.29502	1.86585
q63_clear_benefits_for_all_health_safety	24	9.00	6.8333	.31661	1.55106
q64_training_education_health_safety	25	9.00	7.6400	.19900	.99499
q65_innovation_innovative_thinking_health_safety	24	9.00	7.0000	.32415	1.58800
q66_early_key_project_participants_health_safety	33	9.00	5.9091	.43598	2.50454
q67_team_building_teamwork_health_safety	43	9.00	6.7907	.32530	2.13316
q68_team_selection_criteria_health_safety	22	9.00	6.3636	.53268	2.49848
q69_collaborative_decision_making_health_safety	21	9.00	6.5238	.41758	1.91361
q70_planning_health_safety	23	9.00	6.7826	.40235	1.92959
q71_early_goal_definition_health_safety	36	9.00	6.1389	.36548	2.19288
q72_reward_structure_linked_to_success_health_safety	19	9.00	6.3684	.46648	2.03335
q73_appropriate_use_of_technology_health_safety	21	9.00	6.4762	.47619	2.18218
q74_shared_bim_health_safety	17	9.00	6.7647	.40701	1.67815
q75_intensive_owner_involvement_health_safety	31	9.00	5.0000	.40956	2.28035
q76_owner_commitment_health_safety	29	9.00	5.8276	.44131	2.37651
q77_location_health_safety	28	8.00	5.1071	.33070	1.74991
q78_open_continuous_communication_health_safety	38	9.00	6.2895	.35960	2.21674
q79_project_type_experience_health_safety	21	7.00	5.8571	.29508	1.35225
q80_project_manager_leadership_health_safety	20	9.00	7.5000	.37346	1.67017
q81_information_share_health_safety	27	9.00	6.9259	.26108	1.35663
q82_continuous_improvement_health_safety	27	9.00	6.8148	.36216	1.88184
q83_knowledge_share_health_safety	32	9.00	6.2187	.26841	1.51837
q84_eliminate_multilayer_subcontractors_health_safety	25	8.00	5.4800	.43635	2.18174
q85_common_goals_health_safety	75	9.00	2.9333	.38827	3.36249
q86_responsibilities_accountability_health_safety	23	9.00	6.8261	.23230	1.11405
q87_contracting_structure_health_safety	31	9.00	6.9677	.33914	1.88828
q88_facilitator_health_safety	24	8.00	4.9167	.38971	1.90917
q89_project_delivery_method_health_safety	20	8.00	5.6000	.35836	1.60263
q90_adequate_resources_health_safety	20	9.00	5.5500	.43210	1.93241
q91_top_management_support_health_safety	15	9.00	5.6000	.45565	1.76473
q92_long_term_commitment_health_safety	27	8.00	6.5556	.20208	1.05003
q93_efficient_coordination_health_safety	24	9.00	6.2917	.45635	2.23566
q94_understanding_others_needs_health_safety	38	9.00	4.9474	.34761	2.14284
q95_subcontractor_involvement_health_safety	24	9.00	6.8750	.43118	2.11233
q96_facility_manager_involvement_health_safety	23	7.00	5.5217	.27310	1.30974
q97_less_reliance_contracts_health_safety	18	9.00	4.8333	.61170	2.59524
q98_open_book_accounting_health_safety	23	8.00	5.8696	.43695	2.09554
q99_personal_attitude_commitment_health_safety	18	9.00	7.5000	.47999	2.03643
q100_timely_responsiveness_health_safety	21	9.00	5.6190	.42244	1.93588
q101_company_culture_health_safety	27	9.00	6.2963	.31038	1.61280
q102_team_experience_health_safety	22	9.00	7.1818	.21458	1.00647
Valid N (listwise)	0				

Table 135- Descriptive statistics of the potential impact of each integration attribute on environmental impact or sustainability

Descriptive Statistics

	N	Maximum	Mean		Std. Deviation
	Statistic	Statistic	Statistic	Std. Error	Statistic
q59_adequate_risk_management_environmental_impact_sustainability	49	9.00	6.3878	.27942	1.95593
q60_internal_conflict_resolution_environmental_impact_sustainabi	33	9.00	5.6364	.29458	1.69223
q61_performance_culture_environmental_impact_sustainability	26	9.00	6.4231	.31949	1.62906
q62trust_environmental_impact_sustainability	40	9.00	5.5000	.32225	2.03810
q63_clear_benefits_for_all_environmental_impact_sustainability	24	9.00	6.0000	.36116	1.76930
q64_training_education_environmental_impact_sustainability	25	9.00	7.6400	.24413	1.22066
q65_innovation_innovative_thinking_environmental_impact_sustaina	24	8.00	6.5833	.37550	1.83958
q66_early_key_project_participants_environmental_impact_sustaina	33	9.00	6.2121	.34476	1.98049
q67_team_building_teamwork_environmental_impact_sustainability	43	9.00	5.3023	.32526	2.13290
q68_team_selection_criteria_environmental_impact_sustainability	22	9.0	5.773	.5136	2.4089
q69_collaborative_decision_making_environmental_impact_sustainab	21	9.00	6.1905	.43435	1.99045
q70_planning_environmental_impact_sustainability	23	8.00	6.0870	.37676	1.80688
q71_early_goal_definition_environmental_impact_sustainability	34	9.00	6.0000	.33776	1.96946
q72_reward_structure_linked_to_success_environmental_impact_sust	19	8.00	5.6842	.42614	1.85750
q73_appropriate_use_of_technology_environmental_impact_sustainab	21	9.00	5.8571	.40406	1.85164
q74_shared_bim_environmental_impact_sustainability	17	8.00	6.5294	.28592	1.17886
q75_intensive_owner_involv_environmental_impact_sustainability	31	9.00	6.1613	.39648	2.20751
q76_owner_commitment_environmental_impact_sustainability	29	9.00	6.4483	.37987	2.04566
q77_location_environmental_impact_sustainability	28	8.00	5.1429	.38392	2.03150
q78_open_cont_communication_environmental_impact_sustainability	38	9.00	5.9211	.34440	2.12300
q79_project_type_experience_environmental_impact_sustainability	21	7.00	3.9048	.27520	1.26114
q80_project_manager_leadership_env_impact_sustainability	20	9.00	6.4500	.31183	1.39454
q81_information_share_environmental_impact_sustainability	27	9.00	6.5926	.38215	1.98570
q82_continuous_improvement_environmental_impact_sustainability	27	9.00	6.3333	.37363	1.94145
q83_knowledge_share_environmental_impact_sustainability	32	9.00	6.2813	.32452	1.83574
q84_eliminate_multilayer_subs_env._impact_sustainability	25	9.00	5.2000	.44347	2.21736
q85_common_goals_environmental_impact_sustainability	75	9.00	3.0533	.39451	3.41655
q86_responsibilities_accountability_env_impact_sustainability	23	9.00	6.6522	.34210	1.64064
q87_contracting_structure_environmental_impact_sustainability	30	9.00	5.6333	.29354	1.60781
q88_facilitator_environmental_impact_sustainability	23	8.00	4.3478	.43833	2.10214
q89_project_delivery_method_environmental_impact_sustainability	20	9.00	6.0000	.45883	2.05196
q90_adequate_resources_environmental_impact_sustainability	20	9.00	5.1500	.42473	1.89945
q91_top_management_support_environmental_impact_sustainability	15	8.00	5.6667	.45426	1.75933
q92_long_term_commitment_environmental_impact_sustainability	27	9.00	6.2963	.21227	1.10296
q93_efficient_coordination_environmental_impact_sustainability	24	9.00	7.0000	.25538	1.25109
q94_understanding_others_needs_env_impact_sustainability	38	9.00	5.3421	.34002	2.09602
q95_subcontractor_involvement_env_impact_sustainability	24	9.00	6.4583	.37095	1.81729
q96_facility_manager_involv_environmental_impact_sustainability	23	9.00	5.2609	.28959	1.38883
q97_less_reliance_contracts_environmental_impact_sustainability	18	8.00	4.3333	.45733	1.94029
q98_open_book_accounting_environmental_impact_sustainability	23	8.00	5.5217	.45279	2.17150
q99_personal_attitude_commitment_env_impact_sustainability	18	9.00	5.9444	.52063	2.20887
q100_timely_responsiveness_environmental_impact_sustainability	21	7.00	5.0952	.27520	1.26114
q101_company_culture_environmental_impact_sustainability	27	8.00	5.8889	.22222	1.15470
q102_team_experience_environmental_impact_sustainability	22	9.00	7.5455	.23473	1.10096
Valid N (listwise)	0				

Table 136- Descriptive statistics of the potential impact of each integration attribute on quality

Quality

Descriptive Statistics

	N	Maximum	Mean		Std. Deviation
	Statistic	Statistic	Statistic	Std. Error	Statistic
q59_adequate_risk_management_quality	47	9.00	7.4255	.22297	1.52864
q60_internal_conflict_resolution_quality	34	9.00	7.6176	.26031	1.51787
q61_performance_culture_quality	26	9.00	7.9231	.22819	1.16355
q62_trust_quality	40	9.00	6.9250	.32103	2.03038
q63_clear_benefits_for_all_quality	24	9.00	7.7500	.37227	1.82376
q64_training_education_quality	25	9.00	8.3600	.16207	.81035
q65_innovation_innovative_thinking_quality	24	9.00	7.6250	.14512	.71094
q66_early_key_project_participants_quality	33	9.00	7.7576	.20885	1.19975
q67_team_building_teamwork_quality	43	9.00	7.1628	.24887	1.63198
q68_team_selection_criteria_quality	21	9.00	8.2381	.15283	.70034
q69_collaborative_decision_making_quality	21	9.00	7.7143	.42618	1.95302
q70_planning_quality	23	9.00	7.6087	.32510	1.55911
q71_early_goal_definition_quality	36	9.00	6.9722	.27454	1.64727
q72_reward_structure_linked_to_success_quality	19	9.00	7.1579	.36082	1.57280
q73_appropriate_use_of_technology_quality	21	9.00	7.6667	.27021	1.23828
q74_shared_bim_quality	17	9.00	7.3529	.33145	1.36662
q75_intensive_owner_involvement_quality	31	9.00	7.0645	.31086	1.73081
q76_owner_commitment_quality	29	9.00	7.2759	.38087	2.05107
q77_location_quality	28	9.00	7.0000	.38832	2.05480
q78_open_continuous_communication_quality	38	9.00	7.3947	.26005	1.60303
q79_project_type_experience_quality	21	8.00	6.3810	.12866	.58959
q80_project_manager_leadership_quality	20	9.00	8.1000	.16059	.71818
q81_information_share_quality	26	9.00	8.2308	.17809	.90808
q82_continuous_improvement_quality	27	9.00	8.1481	.14815	.76980
q83_knowledge_share_quality	32	9.00	7.7500	.20080	1.13592
q84_eliminate_multilayer_subcontractors_quality	25	9.00	6.7600	.31241	1.56205
q85_common_goals_quality	75	9.00	3.5733	.42793	3.70600
q86_responsibilities_accountability_quality	23	9.00	7.9130	.25079	1.20276
q87_contracting_structure_quality	30	9.00	7.8667	.19613	1.07425
q88_facilitator_quality	24	9.00	5.8333	.42846	2.09900
q89_project_delivery_method_quality	20	9.00	7.0500	.35150	1.57196
q90_adequate_resources_quality	20	9.00	6.9000	.38320	1.71372
q91_top_management_support_quality	15	9.00	6.3333	.48469	1.87718
q92_long_term_commitment_quality	27	9.00	7.8889	.12327	.64051
q93_efficient_coordination_quality	24	9.00	7.5833	.15830	.77553
q94_understanding_others_needs_quality	38	9.00	6.9211	.25961	1.60036
q95_subcontractor_involvement_quality	24	9.00	8.3750	.18855	.92372
q96_facility_manager_involvement_quality	23	9.00	7.4783	.30066	1.44189
q97_less_reliance_contracts_quality	18	9.00	6.7222	.43390	1.84089
q98_open_book_accounting_quality	23	8.00	6.3478	.41517	1.99109
q99_personal_attitude_commitment_quality	18	9.00	7.5000	.27116	1.15045
q100_timely_responsiveness_quality	21	9.00	6.4762	.31335	1.43593
q101_company_culture_quality	27	9.00	7.5556	.21572	1.12090
q102_team_experience_quality	22	9.00	8.3182	.19054	.89370
Valid N (listwise)	0				

Table 137- Descriptive statistics of the potential impact of each integration attribute on functionality

Functionality

Descriptive Statistics

	N	Maximum	Mean		Std. Deviation
	Statistic	Statistic	Statistic	Std. Error	Statistic
q59_adequate_risk_management_functionality	49	9.00	6.2449	.32931	2.30516
q60_internal_conflict_resolution_functionality	34	9.00	6.8824	.28872	1.68352
q61_performance_culture_functionality	26	9.00	6.7308	.37027	1.88802
q62_trust_functionality	40	9.00	6.0500	.34521	2.18327
q63_clear_benefits_for_all_functionality	24	9.00	7.2917	.30974	1.51741
q64_training_education_functionality	25	9.00	7.7200	.18726	.93630
q65_innovation_innovative_thinking_functionality	24	9.00	6.5417	.24803	1.21509
q66_early_key_project_participants_functionality	33	9.00	7.3030	.27346	1.57092
q67_team_building_teamwork_functionality	43	9.00	6.1163	.34935	2.29086
q68_team_selection_criteria_functionality	22	9.00	6.7727	.57709	2.70681
q69_collaborative_decision_making_functionality	21	9.00	7.2381	.47762	2.18872
q70_planning_functionality	23	9.00	6.2609	.40363	1.93573
q71_early_goal_definition_functionality	36	9.00	6.3889	.30674	1.84046
q72_reward_structure_linked_to_success_functionality	19	9.00	7.1579	.48524	2.11511
q73_appropriate_use_of_technology_functionality	21	9.00	7.6667	.32611	1.49443
q74_shared_bim_functionality	17	9.00	6.5882	.45422	1.87279
q75_intensive_owner_involvement_functionality	31	9.00	7.0645	.40939	2.27941
q76_owner_commitment_functionality	29	9.00	7.3103	.35478	1.91056
q77_location_functionality	28	8.00	5.8929	.35389	1.87260
q78_open_continuous_communication_functionality	38	9.00	6.4737	.33253	2.04988
q79_project_type_experience_functionality	21	7.00	6.3333	.10541	.48305
q80_project_manager_leadership_functionality	20	9.00	7.0500	.21120	.94451
q81_information_share_functionality	27	9.00	7.9259	.24993	1.29870
q82_continuous_improvement_functionality	27	9.00	7.6296	.30731	1.59683
q83_knowledge_share_functionality	32	9.00	6.4375	.35904	2.03101
q84_eliminate_multilayer_subcontractors_functionality	25	9.00	5.6800	.41921	2.09603
q85_common_goals_functionality	75	9.00	3.3733	.41710	3.61219
q86_responsibilities_accountability_functionality	23	9.00	6.8696	.30350	1.45553
q87_contracting_structure_functionality	31	9.00	6.6774	.28355	1.57876
q88_facilitator_functionality	24	9.00	5.2083	.45036	2.20630
q89_project_delivery_method_functionality	20	9.00	6.8500	.36473	1.63111
q90_adequate_resources_functionality	20	9.00	6.0000	.42920	1.91943
q91_top_management_support_functionality	15	9.00	5.6667	.48469	1.87718
q92_long_term_commitment_functionality	27	9.00	7.2963	.20544	1.06752
q93_efficient_coordination_functionality	24	9.00	7.0833	.34535	1.69184
q94_understanding_others_needs_functionality	38	9.00	6.8684	.32041	1.97513
q95_subcontractor_involvement_functionality	24	9.00	7.1250	.38689	1.89536
q96_facility_manager_involvement_functionality	23	9.00	8.4783	.15232	.73048
q97_less_reliance_contracts_functionality	18	9.00	4.3889	.47237	2.00408
q98_open_book_accounting_functionality	23	8.00	5.9565	.41929	2.01084
q99_personal_attitude_commitment_functionality	18	9.00	6.7778	.45414	1.92676
q100_timely_responsiveness_functionality	21	9.00	5.4762	.40602	1.86062
q101_company_culture_functionality	27	9.00	5.8889	.28412	1.47631
q102_team_experience_functionality	21	9.00	7.8095	.14831	.67964
Valid N (listwise)	0				

Table 138 Descriptive statistics of the potential impact of each integration attribute on user satisfaction

User Satisfaction

Descriptive Statistics

	N	Maximum	Mean		Std. Deviation
	Statistic	Statistic	Statistic	Std. Error	Statistic
q59_adequate_risk_management_user_satisfaction	49	9.00	6.5510	.34014	2.38101
q60_internal_conflict_resolution_user_satisfaction	34	9.00	7.0882	.21680	1.26414
q61_culture_user_satisfaction	26	9.00	6.5769	.30970	1.57919
q62_trust_user_satisfaction	39	9.00	6.7179	.35796	2.23546
q63_clear_benefits_for_all_user_satisfaction	24	9.00	7.2500	.35227	1.72576
q64_training_education_user_satisfaction	25	9.00	7.6000	.23805	1.19024
q65_innovation_innovative_thinking_user_satisfaction	24	9.00	7.0000	.32415	1.58800
q66_early_key_project_participants_user_satisfaction	33	9.00	6.4848	.32602	1.87285
q67_team_building_teamwork_user_satisfaction	42	9.00	6.6667	.27826	1.80334
q68_team_selection_criteria_user_satisfaction	22	9.00	6.6364	.43913	2.05971
q69_collaborative_decision_making_user_satisfaction	21	9.00	7.4762	.34928	1.60060
q70_planning_user_satisfaction	23	9.00	6.2174	.43081	2.06610
q71_early_goal_definition_user_satisfaction	36	9.00	6.9444	.28989	1.73937
q72_reward_structure_linked_to_success_user_satisfaction	19	9.00	6.8421	.45411	1.97943
q73_appropriate_use_of_technology_user_satisfaction	20	9.00	7.0000	.31623	1.41421
q74_shared_bim_user_satisfaction	17	9.00	6.7647	.49653	2.04724
q75_intensive_owner_involvement_user_satisfaction	31	9.00	7.6774	.28355	1.57876
q76_owner_commitment_user_satisfaction	29	9.00	7.5517	.36330	1.95642
q77_location_user_satisfaction	28	9.00	6.4286	.43773	2.31626
q78_open_continuous_communication_user_satisfaction	38	9.00	7.1053	.30823	1.90006
q79_project_type_experience_user_satisfaction	21	8.00	6.2857	.14046	.64365
q80_project_manager_leadership_user_satisfaction	20	9.00	7.2000	.38798	1.73509
q81_information_share_user_satisfaction	27	9.00	6.5556	.47241	2.45472
q82_continuous_improvement_user_satisfaction	27	9.00	7.8889	.29397	1.52753
q83_knowledge_share_user_satisfaction	32	9.00	6.4688	.37830	2.14001
q84_eliminate_multilayer_subcontractors_user_satisfaction	25	9.00	6.1200	.34312	1.71561
q85_common_goals_user_satisfaction	75	9.00	3.3867	.41542	3.59765
q86_responsibilities_accountability_user_satisfaction	23	9.00	7.1304	.34033	1.63219
q87_contracting_structure_user_satisfaction	31	9.00	6.3548	.38395	2.13773
q88_facilitator_user_satisfaction	24	9.00	5.3750	.42907	2.10202
q89_project_delivery_method_user_satisfaction	20	9.00	6.8500	.30153	1.34849
q90_adequate_resources_user_satisfaction	20	9.00	6.0000	.47573	2.12751
q91_top_management_support_user_satisfaction	15	9.00	6.8000	.49952	1.93465
q92_long_term_commitment_user_satisfaction	27	9.00	7.3333	.21350	1.10940
q93_efficient_coordination_user_satisfaction	24	9.00	7.1667	.33872	1.65940
q94_understanding_others_needs_user_satisfaction	38	9.00	6.0000	.34772	2.14350
q95_subcontractor_involvement_user_satisfaction	24	9.00	7.5000	.36116	1.76930
q96_facility_manager_involvement_user_satisfaction	23	9.00	8.4783	.15232	.73048
q97_less_reliance_contracts_user_satisfaction	18	9.00	5.2778	.57625	2.44482
q98_open_book_accounting_user_satisfaction	23	9.00	6.2609	.47556	2.28070
q99_personal_attitude_commitment_user_satisfaction	18	9.00	6.3889	.46540	1.97451
q100_timely_responsiveness_user_satisfaction	21	9.00	6.1905	.46095	2.11232
q101_company_culture_user_satisfaction	27	9.00	5.5185	.41814	2.17274
q102_team_experience_user_satisfaction	22	9.00	7.8636	.13636	.63960
Valid N (listwise)	0				

Table 139- Descriptive statistics of the potential impact of each integration attribute on cost

Owner Satisfaction

Descriptive Statistics

	N	Maximum	Mean		Std. Deviation
	Statistic	Statistic	Statistic	Std. Error	Statistic
q59_adequate_risk_management_owner_satisfaction	49	9.00	7.1633	.31990	2.23930
q60_internal_conflict_resolution_owner_satisfaction	34	9.00	7.5882	.17971	1.04787
q61_performance_culture_owner_satisfaction	26	9.00	7.8846	.20250	1.03255
q62_trust_owner_satisfaction	40	9.00	7.5000	.27503	1.73944
q63_clear_benefits_for_all_owner_satisfaction	24	9.00	8.1250	.23554	1.15392
q64_training_education_owner_satisfaction	25	9.00	7.6400	.29371	1.46856
q65_innovation_innovative_thinking_owner_satisfaction	24	9.00	7.8333	.26694	1.30773
q66_early_key_project_participants_owner_satisfaction	33	9.00	7.5758	.24630	1.41488
q67_team_building_teamwork_owner_satisfaction	43	9.00	7.2791	.29639	1.94356
q68_team_selection_criteria_owner_satisfaction	22	9.00	7.8636	.17771	.83355
q69_collaborative_decision_making_owner_satisfaction	21	9.00	7.4762	.35603	1.63153
q70_planning_owner_satisfaction	23	9.00	7.4783	.34931	1.67521
q71_early_goal_definition_owner_satisfaction	35	9.00	7.5429	.28208	1.66879
q72_reward_structure_linked_to_success_owner_satisfaction	19	9.00	7.7368	.34912	1.52177
q73_appropriate_use_of_technology_owner_satisfaction	21	9.00	7.3810	.33435	1.53219
q74_shared_bim_owner_satisfaction	17	9.00	6.8235	.44750	1.84510
q75_intensive_owner_involvement_owner_satisfaction	31	9.00	8.5161	.11236	.62562
q76_owner_commitment_owner_satisfaction	29	9.00	8.3448	.18752	1.00980
q77_location_owner_satisfaction	28	9.00	6.3929	.36129	1.91174
q78_open_continuous_communication_owner_satisfaction	38	9.00	7.8947	.24671	1.52084
q79_project_type_experience_owner_satisfaction	21	7.00	6.1429	.07825	.35857
q80_project_manager_leadership_owner_satisfaction	20	9.00	7.8000	.17168	.76777
q81_information_share_owner_satisfaction	27	9.00	7.9630	.20312	1.05544
q82_continuous_improvement_owner_satisfaction	27	9.00	8.1111	.20208	1.05003
q83_knowledge_share_owner_satisfaction	32	9.00	7.3125	.27104	1.53323
q84_eliminate_multilayer_subcontractors_owner_satisfaction	25	9.00	6.1200	.30177	1.50886
q85_common_goals_owner_satisfaction	75	9.00	3.8933	.46405	4.01878
q86_responsibilities_accountability_owner_satisfaction	23	9.00	7.5217	.31353	1.50362
q87_contracting_structure_owner_satisfaction	31	9.00	7.7742	.28852	1.60644
q88_facilitator_owner_satisfaction	24	9.00	6.0417	.39231	1.92194
q89_project_delivery_method_owner_satisfaction	20	9.00	8.3500	.22094	.98809
q90_adequate_resources_owner_satisfaction	20	9.00	6.9500	.32016	1.43178
q91_top_management_support_owner_satisfaction	14	9.00	7.8571	.25370	.94926
q92_long_term_commitment_owner_satisfaction	27	9.00	7.5926	.17096	.88835
q93_efficient_coordination_owner_satisfaction	24	9.00	7.2500	.31422	1.53934
q94_understanding_others_needs_owner_satisfaction	38	9.00	7.3947	.29346	1.80898
q95_subcontractor_involvement_owner_satisfaction	24	9.00	8.0833	.16936	.82970
q96_facility_manager_involvement_owner_satisfaction	23	9.00	8.2609	.14360	.68870
q97_less_reliance_contracts_owner_satisfaction	18	9.00	7.5000	.34537	1.46528
q98_open_book_accounting_owner_satisfaction	23	9.00	6.9130	.38711	1.85651
q99_personal_attitude_commitment_owner_satisfaction	17	9.00	7.7059	.22303	.91956
q100_timely_responsiveness_owner_satisfaction	21	9.00	6.7619	.38362	1.75798
q101_company_culture_owner_satisfaction	27	9.00	6.2593	.24803	1.28879
Valid N (listwise)	0				

Table 140- Descriptive statistics of the potential impact of each integration attribute on design team satisfaction

Design Team Satisfaction

Descriptive Statistics

	N	Maximum	Mean		Std. Deviation
	Statistic	Statistic	Statistic	Std. Error	Statistic
q59adequate_risk_management_design_team_satisfaction	49	9.00	6.6939	.24606	1.72245
q60_internal_conflict_resolution_design_team_satisfaction	34	9.00	6.5294	.21209	1.23669
q61_performance_culture_design_team_satisfaction	26	9.00	6.7308	.25755	1.31325
q62_trust_design_team_satisfaction	40	9.00	6.5000	.29308	1.85362
qu63_clear_benefits_for_all_design_team_satisfaction	24	9.00	6.9583	.27240	1.33447
q64_training_education_design_team_satisfaction	25	9.00	6.2000	.26458	1.32288
q65_innovation_innovative_thinking_design_team_satisfaction	24	9.00	6.5417	.39462	1.93321
q66_early_key_project_participants_design_team_satisfaction	33	9.00	6.6970	.24804	1.42489
q67_team_building_teamwork_design_team_satisfaction	43	9.00	7.1163	.24726	1.62142
q68_team_selection_criteria_design_team_satisfaction	22	9.00	7.6818	.29707	1.39340
q69_collaborative_decision_making_design_team_satisfaction	21	9.00	6.9524	.32715	1.49921
q70_planning_design_team_satisfaction	23	9.00	6.6522	.35346	1.69515
q71_early_goal_definition_design_team_satisfaction	36	9.00	6.8333	.31244	1.87464
q72_reward_structure_linked_to_success_design_team_satisfaction	19	9.00	6.6316	.26722	1.16479
q73_appropriate_use_of_technology_design_team_satisfaction	21	9.00	6.9524	.31226	1.43095
q74_shared_bim_design_team_satisfaction	17	9.00	6.4706	.42111	1.73629
q75_intensive_owner_involvement_design_team_satisfaction	31	9.00	7.0968	.24694	1.37489
q76_owner_commitment_design_team_satisfaction	29	9.00	6.7241	.32505	1.75044
q77_location_design_team_satisfaction	28	9.00	7.0357	.31907	1.68835
q78_open_continuous_communication_design_team_satisfaction	38	9.00	6.8684	.33132	2.04240
q79_project_type_experience_design_team_satisfaction	21	8.00	7.2381	.11761	.53896
q80_project_manager_leadership_design_team_satisfaction	20	9.00	6.6000	.32767	1.46539
q81_information_share_design_team_satisfaction	27	9.00	7.7778	.19490	1.01274
q82_continuous_improvement_design_team_satisfaction	27	9.00	7.2222	.31276	1.62512
q83_knowledge_share_design_team_satisfaction	32	9.00	6.8750	.23223	1.31370
q84_eliminate_multilayer_subcontractors_design_team_satisfaction	25	8.00	5.1200	.42158	2.10792
q85_common_goals_design_team_satisfaction	75	9.00	3.6000	.43371	3.75608
q86_responsibilities_accountability_design_team_satisfaction	23	9.00	7.0000	.22668	1.08711
q87_contracting_structure_design_team_satisfaction	31	9.00	7.0000	.20214	1.12546
q88_facilitator_design_team_satisfaction	24	8.00	5.6667	.39318	1.92617
q89_project_delivery_method_design_team_satisfaction	20	9.00	7.0000	.30779	1.37649
q90_adequate_resources_design_team_satisfaction	20	9.00	6.1500	.34240	1.53125
q91_top_management_support_design_team_satisfaction	15	9.00	6.6667	.45426	1.75933
q92_long_term_commitment_design_team_satisfaction	27	9.00	7.2963	.27640	1.43620
q93_efficient_coordination_design_team_satisfaction	24	9.00	7.0833	.27529	1.34864
q94_understanding_others_needs_design_team_satisfaction	38	9.00	7.0526	.23233	1.43220
q95_subcontractor_involvement_design_team_satisfaction	24	9.00	8.0000	.22522	1.10335
q96_facility_manager_involvement_design_team_satisfaction	23	9.00	6.8696	.26898	1.28997
q97_less_reliance_contracts_design_team_satisfaction	18	9.00	6.8889	.34194	1.45072
q98_open_book_accounting_design_team_satisfaction	23	8.00	6.1304	.30350	1.45553
q99_personal_attitude_commitment_design_team_satisfaction	18	9.00	7.4444	.30489	1.29352
q100_timely_responsiveness_design_team_satisfaction	21	9.00	6.8095	.37556	1.72102
q101_company_culture_design_team_satisfaction	27	9.00	7.2963	.23152	1.20304
q102_team_experience_design_team_satisfaction	22	8.00	7.0909	.20711	.97145
Valid N (listwise)	0				

Table 141- Descriptive statistics of the potential impact of each integration attribute on construction team satisfaction

Construction Team Satisfaction

Descriptive Statistics

	N	Maximum	Mean		Std. Deviation
	Statistic	Statistic	Statistic	Std. Error	Statistic
q59_adequate_risk_management_construction_team_satisfaction	49	9.00	6.7347	.22919	1.60436
q60_internal_conflict_resolution_construction_team_satisfaction	34	9.00	6.4706	.19456	1.13445
q62_trust_construction_team_satisfaction	40	9.00	7.1000	.24495	1.54919
q63_clear_benefits_for_all_construction_team_satisfaction	24	9.00	7.3333	.23825	1.16718
q64_training_education_construction_team_satisfaction	25	8.00	6.4800	.27154	1.35769
q65_innovation_innovative_thinking_construction_team_satisfactio	24	9.00	6.9167	.29437	1.44212
q66_early_key_project_participants_construction_team_satisfactio	33	9.00	6.7576	.31088	1.78589
q67_team_building_teamwork_construction_team_satisfaction	43	9.00	7.0698	.24088	1.57956
q68_team_selection_criteria_construction_team_satisfaction	22	9.00	7.6364	.31241	1.46533
q69_collaborative_decision_making_construction_team_satisfaction	21	9.00	7.0952	.33026	1.51343
q70_planning_construction_team_satisfaction	23	9.00	7.1739	.29922	1.43502
q71_early_goal_definition_construction_team_satisfaction	36	9.00	6.3333	.29814	1.78885
q72_reward_structure_linked_to_success_construction_team_satisfa	18	9.00	7.3333	.26813	1.13759
q73_appropriate_use_of_technology_construction_team_sat	21	9.00	7.0476	.29662	1.35927
q74_shared_bim_construction_team_satisfaction	17	9.00	6.7059	.39075	1.61108
q75_intensive_owner_involvement_construction_team_satisfaction	31	9.00	6.8387	.26273	1.46280
q76_owner_commitment_construction_team_satisfaction	29	9.00	6.7586	.36690	1.97584
q77_location_construction_team_satisfaction	28	9.00	7.0357	.30638	1.62121
q78_open_continuous_communication_construction_team_satisfaction	38	9.00	7.1842	.29663	1.82853
q79_project_type_experience_construction_team_satisfaction	21	9.00	8.0952	.09524	.43644
q80_project_manager_leadership_construction_team_satisfaction	20	9.00	7.7000	.19331	.86450
q81_information_share_construction_team_satisfaction	27	9.00	6.9259	.23221	1.20658
q82_continuous_improvement_construction_team_satisfaction	27	9.00	7.8148	.19998	1.03912
q83_knowledge_share_construction_team_satisfaction	32	9.00	6.9687	.23108	1.30716
q84_eliminate_multilayer_sub_construction_team_satisfaction	25	9.00	6.8400	.28095	1.40475
q85_common_goals_construction_team_satisfaction	75	9.00	3.8133	.44669	3.86842
q86_resp_accountability_construction_team_satisfaction	23	9.00	7.0435	.23081	1.10693
q87_contracting_structure_construction_team_satisfaction	31	9.00	7.0000	.26640	1.48324
q88_facilitator_construction_team_satisfaction	24	8.00	5.5000	.39009	1.91107
q89_project_delivery_method_construction_team_satisfaction	20	9.00	6.7000	.37063	1.65752
q90_adequate_resources_construction_team_satisfaction	20	9.00	6.7500	.35448	1.58529
q91_top_management_support_construction_team_satisfaction	15	9.00	7.6000	.25448	.98561
q92_long_term_commitment_construction_team_satisfaction	27	9.00	7.2593	.34007	1.76706
q93_efficient_coordination_construction_team_satisfaction	24	9.00	7.3333	.24574	1.20386
q94_understanding_others_needs_construction_team_satisfaction	38	9.00	7.1053	.20928	1.29008
q95_subcontractor_involvement_construction_team_satisfaction	24	9.00	8.2500	.25714	1.25974
q96_facility_manager_involvement_construction_team_satisfaction	23	8.00	6.1739	.27152	1.30217
q97_less_reliance_contracts_construction_team_satisfaction	18	9.00	6.7222	.39445	1.67352
q98_open_book_accounting_construction_team_satisfaction	23	9.00	7.0435	.29137	1.39734
q99_personal_attitude_commitment_construction_team_satisfaction	18	9.00	8.3333	.18078	.76696
q100_timely_responsiveness_construction_team_satisfaction	21	9.00	7.1429	.26979	1.23635
q102_team_experience_construction_team_satisfaction	22	8.00	7.6364	.10497	.49237
Valid N (listwise)	0				

Table 142- Descriptive statistics of the potential impact of each integration attribute on productivity

Productivity

Descriptive Statistics

	N	Maximum	Mean		Std. Deviation
	Statistic	Statistic	Statistic	Std. Error	Statistic
q59_adequate_risk_management_productivity	49	9.00	6.6122	.27482	1.92372
q60_internal_conflict_resolution_productivity	34	9.00	7.2941	.22551	1.31494
q61_performance_culture_poductivity	26	9.00	7.6154	.16712	.85215
q62trust_productivity	40	9.00	7.3250	.27360	1.73038
qu63_clear_benefits_for_all_productivity	24	9.00	7.3750	.29983	1.46888
q64_training_education_productivity	25	9.00	7.5600	.23861	1.19304
q65_innovation_innovative_thinking_productivity	24	9.00	6.7917	.24803	1.21509
q66_early_key_project_participants_productivity	33	9.00	7.0303	.26998	1.55090
q67n_team_building_teamwork_productivity	42	9.00	7.0952	.27436	1.77804
q68_team_selection_criteria_productivity	22	9.00	7.7727	.26262	1.23179
q69_collaborative_decision_making_productivity	21	9.00	7.1905	.40011	1.83355
q70_planning_productivity	23	9.00	6.5217	.42113	2.01967
q71_early_goal_definition_productivity	36	9.00	7.1389	.29318	1.75910
q72_reward_structure_linked_to_success_productivity	17	9.00	6.9412	.33727	1.39062
q73_appropriate_use_of_technology_productivity	21	9.00	8.1905	.17754	.81358
q74_shared_bim_productivity	17	8.00	6.9412	.26389	1.08804
q75_intensive_owner_involvement_productivity	31	9.00	6.8387	.25441	1.41649
q76_owner_commitment_productivity	29	9.00	6.7931	.38882	2.09386
q77_location_productivity	28	9.00	6.9643	.40981	2.16850
q78_open_continuous_communication_productivity	38	9.00	6.9211	.30262	1.86550
q79_project_type_experience_productivity	21	8.00	7.0476	.08384	.38421
q80_project_manager_leadership_productivity	20	9.00	7.1500	.24360	1.08942
q81_information_share_productivity	27	9.00	7.9259	.21960	1.14105
q82_continuous_improvement_productivity	27	9.00	7.5556	.35938	1.86740
q83_knowledge_share_productivity	32	9.00	7.6875	.17061	.96512
q84_eliminate_multilayer_subcontractors_productivity	25	9.00	6.6800	.34986	1.74929
q85_common_goals_productivity	75	9.00	3.6000	.42954	3.71992
q86_responsibilities_accountability_productivity	23	9.00	7.3913	.24942	1.19617
q87_contracting_structure_productivity	31	9.00	7.1613	.29365	1.63497
q88_facilitator_productivity	24	8.00	5.9167	.44606	2.18526
q89_project_delivery_method_productivity	20	9.00	6.9000	.39670	1.77408
q90_adequate_resources_productivity	20	9.00	7.3000	.42364	1.89459
q91_top_management_support_productivity	15	8.00	5.6667	.48469	1.87718
q92_long_term_commitment_productivity	27	9.00	6.7407	.30472	1.58339
q93_efficient_coordination_productivity	24	9.00	7.7917	.33503	1.64129
q94_understanding_others_needs_productivity	38	9.00	6.7895	.26173	1.61342
q95_subcontractor_involvement_productivity	24	9.00	8.4167	.17974	.88055
q96_facility_manager_involvement_productivity	23	9.00	6.7391	.28268	1.35571
q97_less_reliance_contracts_productivity	18	9.00	6.7778	.37535	1.59247
q98_open_book_accounting_productivity	23	9.00	6.3478	.48131	2.30826
q99_personal_attitude_commitment_productivity	18	9.00	7.7222	.21090	.89479
q100_timely_responsiveness_productivity	21	9.00	6.9048	.31551	1.44585
q101_safety_company_culture_productivity	27	9.00	7.5556	.24069	1.25064
q102_team_experience_productivity	22	8.00	7.2273	.13046	.61193
Valid N (listwise)	0				

Table 143- Descriptive statistics of the potential impact of each integration attribute on claims and litigations

Claims and Litigation

Descriptive Statistics

	N	Maximum	Mean		Std. Deviation
	Statistic	Statistic	Statistic	Std. Error	Statistic
q59_adequate_risk_management_claims_litigation	48	9.00	7.5208	.26629	1.84494
q60_internal_conflict_resolution_claims_litigation	34	9.00	8.0882	.19516	1.13798
q61_mutual_respect_claims_litigation	34	9.00	7.7353	.27462	1.60130
q62_trust_claims_litigation	40	9.00	7.4000	.24232	1.53255
q63_clear_benefits_for_all_claims_litigation	24	9.00	6.2917	.33231	1.62799
q64_training_education_claims_litigation	25	9.00	6.8800	.32823	1.64114
q65_innovation_innovative_thinking_claims_litigation	21	9.00	7.3333	.29547	1.35401
q66_early_key_project_participants_claims_litigation	33	9.00	6.5455	.29223	1.67874
q67_team_building_teamwork_claims_litigation	43	9.00	6.6744	.27182	1.78247
q68_team_selection_criteria_claims_litigation	22	9.00	7.6818	.29707	1.39340
q69_collaborative_decision_making_claims_litigation	21	9.00	6.9524	.31979	1.46548
q70_planning_claims_litigation	23	9.00	6.6957	.41434	1.98711
q71_early_goal_definition_claims_litigation	36	9.00	6.5000	.35967	2.15804
q72_reward_structure_linked_to_success_claims_litigation	19	9.00	6.6842	.40503	1.76549
q73_appropriate_use_of_technology_claims_litigation	21	9.00	6.7143	.37253	1.70713
q74_shared_bim_claims_litigation	17	9.00	6.6471	.45327	1.86886
q75_intensive_owner_involvement_claims_litigation	31	9.00	7.1613	.27473	1.52964
q76_owner_commitment_claims_litigation	29	9.00	6.7241	.38409	2.06841
q77_location_claims_litigation	28	9.00	5.7500	.37665	1.99304
q78_open_continuous_communication_claims_litigation	38	9.00	7.1053	.29886	1.84229
q79_project_type_experience_claims_litigation	21	8.00	6.9048	.13636	.62488
q80_project_manager_leadership_claims_litigation	18	9.00	7.3889	.36280	1.53925
q81_information_share_claims_litigation	27	9.00	7.7778	.27906	1.45002
q82_continuous_improvement_claims_litigation	27	8.00	5.3704	.33397	1.73534
q83_knowledge_share_claims_litigation	32	9.00	6.6563	.36920	2.08852
q84_eliminate_multilayer_subcontractors_claims_litigation	25	9.00	6.5600	.34196	1.70978
q85_common_goals_claims_litigation	75	9.00	2.9867	.38788	3.35911
q86_responsibilities_accountability_claims_litigation	23	9.00	6.8696	.45032	2.15964
q87_contracting_structure_claims_litigation	30	9.00	7.7333	.22961	1.25762
q88_facilitator_claims_litigation	24	9.00	5.2917	.45635	2.23566
q89_project_delivery_method_claims_litigation	20	9.00	7.4000	.38662	1.72901
q90_adequate_resources_claims_litigation	20	8.00	5.8500	.24360	1.08942
q91_top_management_support_claims_litigation	13	9.00	7.3077	.28610	1.03155
q92_long_term_commitment_claims_litigation	27	9.00	7.3333	.25036	1.30089
q93_efficient_coordination_claims_litigation	22	9.00	6.1364	.49803	2.33596
q94_understanding_others_needs_claims_litigation	38	9.00	6.4737	.34513	2.12751
q95_subcontractor_involvement_claims_litigation	24	9.00	7.7083	.27240	1.33447
q96_facility_manager_involvement_claims_litigation	23	9.00	5.7826	.33242	1.59421
q97_less_reliance_contracts_claims_litigation	18	9.00	7.7778	.35751	1.51679
q98_open_book_accounting_claims_litigation	23	9.00	6.3043	.36893	1.76930
q99_personal_attitude_commitment_claims_litigation	18	9.00	7.4444	.28264	1.19913
q100_timely_responsiveness_claims_litigation	21	9.00	6.3810	.36172	1.65759
q101_company_culture_claims_litigation	27	9.00	5.6667	.32467	1.68705
q102_team_experience_claims_litigation	22	9.00	8.0000	.16116	.75593
Valid N (listwise)	0				

APPENDIX O

CLUSTER ANALYSIS FOR INTEGRATION ATTRIBUTES ON PERFORMACE

Table 144- Eigenvalues of the covariance matrix for the integration attributes across performance criteria

The CLUSTER Procedure
Average Linkage Cluster Analysis

Eigenvalues of the Covariance Matrix

	Eigenvalue	Difference	Proportion	Cumulative
1	2.42150300	1.79916308	0.5151	0.5151
2	0.62233992	0.18482876	0.1324	0.6475
3	0.43751116	0.01801471	0.0931	0.7405
4	0.41949645	0.22929543	0.0892	0.8298
5	0.19020102	0.01724791	0.0405	0.8702
6	0.17295311	0.04740471	0.0368	0.9070
7	0.12554840	0.03474587	0.0267	0.9337
8	0.09080253	0.01641305	0.0193	0.9530
9	0.07438948	0.01554318	0.0158	0.9689
10	0.05884630	0.01135002	0.0125	0.9814
11	0.04749628	0.00747341	0.0101	0.9915
12	0.04002287		0.0085	1.0000

Root-Mean-Square Total-Sample Standard Deviation = 0.625907
Mean Distance Between Observations = 2.852754

Table 145- Cluster history for integration attributes across performance criteria

Cluster History

								RMS			
NCL	Clusters Joined		FREQ	STD	SPRSQ	RSQ	ERSQ	CCC	PSF	PST2	Dist e
44	12	29	2	0.1726	0.0017	.998	.	.	13.4	.	0.2964
43	3	23	2	0.1993	0.0023	.996	.		1.8	.	0.3423
42	15	21	2	0.2139	0.0027	.993	.	.	10.9	.	0.3674
41	1	8	2	0.2192	0.0028	.991	.	.	10.5	.	0.3764
40	CL44	35	3	0.2130	0.0035	.987m	.	.	9.7	2.0	0.3909
39	18	32	2	0.2294	0.0031	.984	.	.	9.7	.	0.394
38	2	4	2	0.2492	0.0036	.980	.	.	9.4	.	0.428
37	CL41	17	3	0.2435	0.0041	.976	.	.	9.1	1.5	0.4366
36	20	43	2	0.2561	0.0038	.972	.	.	9.1	.	0.4399
35	6	CL40	4	0.2388	0.0047	.968	.	.	8.8	1.8	0.4454
34	9	26	2	0.2676	0.0042	.964	.	.	8.8	.	0.4596
33	CL37	13	4	0.2586	0.0048	.959	.	.	8.7	1.4	0.4676
32	CL36	33	3	0.2717	0.0048	.954	.	.	8.7	1.2	0.4784
31	11	30	2	0.2827	0.0046	.949	.	.	8.8	.	0.4855
30	CL39	19	3	0.2705	0.0054	.944	.	.	8.7	1.8	0.495
29	CL35	CL42	6	0.2677	0.0082	.936	.	.	8.3	2.6	0.5005
28	10	14	2	0.3010	0.0053	.931	.	.	8.4	.	0.5168
27	CL29	CL34	8	0.2879	0.0087	.922	.	.	8.2	2.1	0.534
26	16	36	2	0.3196	0.0059	.916	.	.	8.3	.	0.5489
25	CL43	CL31	4	0.3027	0.0090	.907	.	.	8.1	2.6	0.5537
24	5	CL28	3	0.3191	0.0066	.900	.	.	8.2	1.2	0.562
23	28	37	2	0.3392	0.0067	.894	.	.	8.4	.	0.5825
22	CL27	CL26	10	0.3104	0.0107	.883	.	.	8.3	2.2	0.5854
21	CL25	42	5	0.3247	0.0085	.874	.	.	8.4	1.6	0.608
20	CL33	CL24	7	0.3321	0.0149	.859	.	.	8.0	3.2	0.6231
19	CL38	CL21	7	0.3537	0.0155	.844	.	.	7.8	2.8	0.6584
18	CL32	CL23	5	0.3543	0.0139	.830	.	.	7.8	2.7	0.6693
17	CL19	CL22	17	0.3698	0.0330	.797	.	.	6.9	5.3	0.69
16	7	45	2	0.4059	0.0096	.788	.	.	7.2	.	0.697
15	CL18	41	6	0.3789	0.0125	.775	.	.	7.4	1.7	0.7258
14	CL20	CL17	24	0.3976	0.0456	.729	.	.	6.4	6.1	0.7332
13	24	38	2	0.4333	0.0109	.719	.	.	6.8	.	0.744
12	CL14	CL30	27	0.4133	0.0382	.680	.	.	6.4	4.4	0.797
11	CL15	44	7	0.4073	0.0161	.664	.	.	6.7	1.9	0.8052
10	CL11	27	8	0.4356	0.0193	.645	.	.	7.1	2.0	0.8592
9	CL16	CL13	4	0.5041	0.0238	.621	.746	-5.4	7.4	2.3	0.9177
8	CL10	22	9	0.4654	0.0234	.598	.722	-5.2	7.9	2.1	0.9499
7	CL8	34	10	0.4895	0.0246	.573	.695	-4.9	8.5	2.0	0.9763
6	CL12	25	28	0.4282	0.0295	.544	.664	-4.7	9.3	3.0	0.9911
5	CL6	CL9	32	0.4736	0.0721	.471	.626	-5.8	8.9	6.5	1.0114
4	CL5	CL7	42	0.5611	0.2204	.251	.577	-9.1	4.6	16.7	1.1327
3	CL4	39	43	0.5720	0.0482	.203	.51	-7.3	5.3	2.6	1.2874
2	31	40	2	0.8677	0.0437	.159	.403	-4.8	8.1	.	1.4901
1	CL3	CL2	45	0.6259	0.1592	.000	.000	.000	.	8.1	1.719

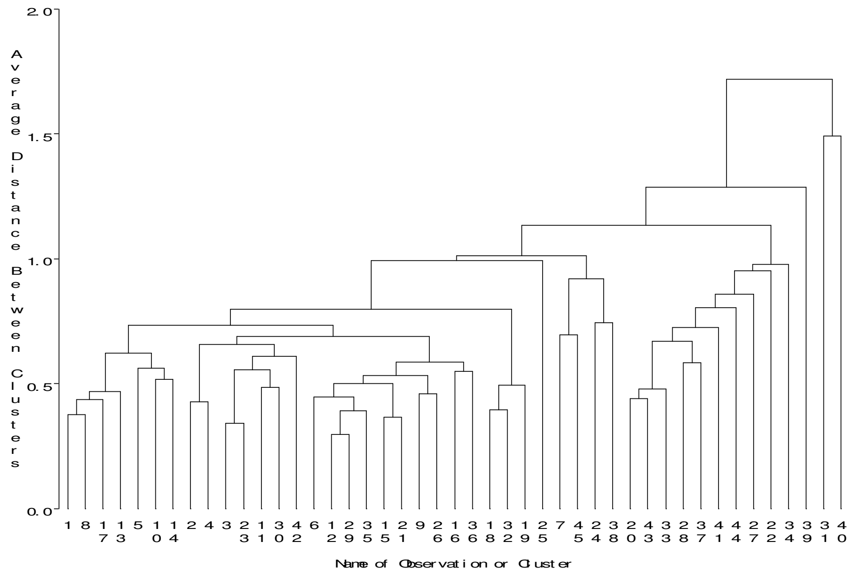

Figure 57- Dendrogram of cluster analysis of integration attributes across performance attributes

APPENDIX P

T-TESTS FOR CLUSTERS OF INTEGRATION ATTRIBUTES ON PERFORMANCE CRITERIA

Table 146- T-test for cluster 1 and cluster 2 of integration attributes on project performance

	Cost	
	Cluster 1	**Cluster 2**
Mean	7.34	6.87
Standard Dev	0.415	0.504
Standard Error of the Mean	0.0733	0.1594
N	32	10
t	3.0069	
p-value	0.0045	

	Time	
	Cluster 1	**Cluster 2**
Mean	7.42	7.07
Standard Dev	0.401	0.252
Standard Error of the Mean	0.0709	0.0798
N	32	10
t	2.6136	
p-value	0.0126	

	Health and Safety	
	Cluster 1	**Cluster 2**
Mean	6.62	5.61
Standard Dev	0.597	0.386
Standard Error of the Mean	0.1055	0.1222
N	32	10
t	4.9877	
p-value	<0.0001	

Table 146 - Continued

	Environmental Impact and Sustainability	
	Cluster 1	Cluster 2
Mean	6.23	5.29
Standard Dev	0.534	0.587
Standard Error of the Mean	0.0945	0.1857
N	32	10
t	4.6632	
p-value	<0.0001	

	Quality	
	Cluster 1	Cluster 2
Mean	7.66	6.77
Standard Dev	0.426	0.394
Standard Error of the Mean	0.0753	0.1246
N	32	10
t	5.8245	
p-value	<0.0001	

	Functionality	
	Cluster 1	Cluster 2
Mean	6.94	6.04
Standard Dev	0.500	0.446
Standard Error of the Mean	0.0885	0.1412
N	32	10
t	5.0734	
p-value	<0.0001	

	User Satisfaction	
	Cluster 1	Cluster 2
Mean	7.00	6.23
Standard Dev	0.456	0.365
Standard Error of the Mean	0.0805	0.1155
N	32	10
t	4.8608	
p-value	<0.0001	

	Owner Satisfaction	
	Cluster 1	Cluster 2
Mean	7.708081568	6.847601201
Standard Dev	0.366961903	0.634171823
Standard Error of the Mean	0.064870313	0.200542739
N	32	10
t	5.3807	
p-value	<0.0001	

Table 146 - Continued

	Design Team Satisfaction	
	Cluster 1	Cluster 2
Mean	6.94	6.66
Standard Dev	0.392	0.680
Standard Error of the Mean	0.0693	0.2152
N	32	10
t	1.6314	
p-value	0.1106	

	Construction Team Satisfaction	
	Cluster 1	Cluster 2
Mean	7.14200916	7.213886673
Standard Dev	0.470169467	0.4084978
Standard Error of the Mean	0.083115005	0.129178347
N	32	10
t	0.4341	
p-value	0.6665	

	Productivity	
	Cluster 1	Cluster 2
Mean	7.27	6.86
Standard Dev	0.455	0.505
Standard Error of the Mean	0.0804	0.1598
N	32	10
t	2.4239	
p-value	0.02	

	Claims and Litigation	
	Cluster 1	Cluster 2
Mean	7.08	6.31
Standard Dev	0.602	0.533
Standard Error of the Mean	0.1064	0.1685
N	32	10
t	3.6462	
p-value	0.0008	

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